MANY SPECIES. ONE PLANET. ONE FUTURE.

अनेक प्रजाति । साझा धर्ति । हाम्रो भविष्य ।

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Agriculture Environment and Biodiversity Section

Singh Durbar, Kathmandu, Nepal

Telephone: 00977-1-4211940

Fax: 00977-1-4211839

Web: www.moac.gov.np

Email: genderequity@moac.gov.np

geed.moac@gmail.com (manuscript submission)

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EDITORIAL

The World Environment Day (June 5) is peoples' day for environmental action. Under the theme **'Many Species. One Planet. One Future'** and as a part of the International year of Biodiversity 2010, this year's event celebrated the incredible diversity of life on this wondrous earth. Rwanda celebrated this year's world Environment Day as a global host country, and organized a vivid celebration focusing on conservation of Gorilla in Volcanoes National Park, Kigali. The day's agenda are to give information about the species and their existence in and extinction from the planet. Millions of species are estimated to inhabit in this marvelous planet; scientists have managed to identify only two millions of them and a huge number of the species is unknown. We don't know whom we have been sharing our life with. The only we do know is the human being whose population is growing, whilst most of other species of flora and fauna becoming fewer and rarer.

The day is celebrated through several events and activities such as street rallies, demonstrations, posters, pamphlets, plantation, TV and radio talks, interactions, seminars and relevant environmental campaigns. Gender Equity and Environment Division in the Ministry of Agriculture and Cooperatives has been publishing the Journal of Agriculture and Environment as a regular program to celebrate the World Environment Day. The division now has brought the journal's new issue, vol.11, in the hand of readerships. This volume essentially includes technical as well as review manuscripts on agriculture environment and population interrelationships and also agricultural biodiversity conservation and utilization. Gender Equity and Environment Division is pleased to release new volume of the journal. The division acknowleges the valuable contributions from authors, reviewers, editors and the editorial management team and hopes that the readers find the issue informative.

Editor-in-Chief

MORE PROFITABLE RICE VARIETIES CROWD BENEFICIAL LANDRACES OUT

Krishna Prasad Pant, PhD[1]

ABSTRACT

The study compares gross revenues from modern rice varieties and landraces and valuates different useful traits of rice landraces to demonstrate an empirical methodology for biodiversity valuation. A sample of 200 rice growers in hills and plain area was surveyed for commercialization of agro-biodiversity project. For estimating the value put by the consumers on different rice traits a hedonic pricing model was used that disaggregates the prices paid by the consumers for different useful traits of rice. The results show that the consumers value aromatic and tasty traits much higher than other traits. As the farmers are earning much lower income from many landraces as compared to that from modern varieties, the farmers are likely to replace them by the modern varieties. The findings of the study will be helpful to prepare market based strategies for rice biodiversity conservation, particularly for the conservation of rice landraces.

Key words: Agrobiodiversity, biodiversity-valuation, hedonic-pricing, rice-landrace, traits

BACKGROUND

Rice biodiversity is a reservoir of rice genetic resources with allelic variations that have vast potential for future rice breeding. The diversity of food plants consists of crop resources that are created and maintained by the farmers as active components of agroecosystems (Brookfield and Padoch, 1994; Vandermeer et al, 1998). Though the need for the conservation of rice biodiversity is agreed by all, the origin of the conflicts for dealing with this issue stems from the rules of division and appropriation of the benefits out of the commercial utilization of the rice genetic resources. Rice being the most important staple food in South and South East Asia, the conservation of the rice diversity and utilization of the diversity for rice breeding are directly related to the food security of this heavily populated part of the world.

Considering the immediate need for addressing food problem, green revolution replacement model of agricultural development is still emphasised whereby landraces are displaced by the so called high yielding and fertilizer responsive modern varieties. As the market supplies high yielding modern varieties of rice, the rational farmers do replace narrow genetic base modern varieties for low productive but rich in other trait landraces they have. A few, genetically uniform, such varieties have replaced genetically variable crop landraces (Brush, 1991; Harlan, 1992). There are many useful traits in landraces that the farmers like. In Nepal, about 53 percent of the farm households continue to grow both modern varieties and landraces simultaneously (Joshi and Bauer, 2006). The farmers generally grow high yielding modern varieties for sales and landraces for family consumption. The farmers having larger size of the rice land demand different high yielding varieties depending on the traits. Their demand for these types is clearly shaped in part as a derived demand from markets, land and soil heterogeneity and in part by the consumption preferences of their families. There is a need to conserve on-farm rice diversity as part of a strategy to conserve crop, rice genetic resources of diverse characteristics. Growing different rice varieties by the farmers to meet different needs is the development approach[2] of the biodiversity conservation. This approach values,

[1] Senior Agricultural Economist, MOAC, kppant@yahoo.com.

[2] There are other approaches to protect biodiversity, including in-situ conservation through protected area conservation, *ex-situ* conservation through zoos, aquaria, botanical gardens, seed banks and gene banks.

conserves, develops and markets agro-biodiversity to alleviate the extreme poverty (Bardsley and Thomas, 2003). However, measuring the value of biodiversity is a great challenge. Reid et al. (1993) observed that even the debates on the measurement of biodiversity started in the 1950s and there is no clear consensus about how the value of biodiversity should be measured. Pearce and Moran (1994) examined some aspects of measurement of biodiversity for genetic diversity, species diversity and ecosystem diversity. According to them, the genetic differences can be measured in terms of phenotypic traits, allelic frequencies or dioxy-ribose nucleic acid (DNA) sequences. The measurements of allelic diversity and DNA sequence, however, require high level technical information which is out of the scope of this paper. The study relies on the phenotypic diversity that is based on measures of phenotypes, involving readily measurable practical utility to the consumers and the farmers. For the purpose of the study the consumers of the products are taken as the market for different traits. Consumers while buying rice considers price and its characteristics. The characteristics they search for fall under three catageries. The first is the selection characteristics like colour and shine of the grain, length of the grain and brand name if any. The second is experience characteristics like cooking qualities (expansion in cooking, non-stickyness) and eating qualities (like aroma and taste). The third set is the credence characteristics like percent of protein and quality of starch which are never known to the ordinary consumers. The analysis is based on the selection and experience characteristics of rice landraces. This paper estimates the use values put by communities for rice diversity to demonstrate their importance to policy makers.

METHODOLOGY

Two districts (Kaski from hill and Bara from Terai Nepal) have been selected purposively considering the richness of the rice varietal diversity. Four villages (Lekhnath and Lumle from Kaski district and Kacharba and Maheshpur from Bara district) with high concentration of the landraces[1] and high yielding modern varieties have been identified by a key informant survey (Pant, 2009). Considering the variations in the study variable, the rice landraces and budget available for the study a sample of 200 households was selected randomly using simple random sampling method without replacement. The pre-tested questionnaire was administered to conduct the survey.

The basic theoretical foundation of the estimation is that the rice consumers pay for different desirable traits of rice as different bundles of the commodity. The capacity of the modern breeding technology that can disaggregate and aggregate different traits in a variety has made this analysis relevant. Empirical estimation of use value of rice genetic diversity is done following hedonic pricing method (HPM)[2]. Early applications of the hedonic pricing methods start from 1920s on farm land characteristics. The first reference of hedonic modeling is found in price differences in fresh vegetables (Waugh, 1928). The basic foundation for application of hedonic pricing method is the expectation that property prices are an increasing function of the environmental quality given the characteristics of the commodity. This paper analyses that market traits of rice rather than its environment related properties. The theoretical foundation of HPM for integrating characteristics in modeling is further elaborated and formalized by Lancaster (1966). According to him environmental characteristics like air or water quality affect the price of land either as a producer good or as a consumer good. The hedonic pricing literature on environmental

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[1] Landraces include farmers' traditional varieties that farmers have produced and maintained themselves, often for many generations, as well as former high yielding varieties that had been bred and were then released more than 15 years and that have since become incorporated into farmers' own seed production (Almekinders and Louwaars 1999; Cleveland and Soleri 2002).

[2] Hedonic pricing method is used to desaggregate the price of a product to different traits the product is having. Here in this paper, the HPM is used for dividing the price paid by the consumers to a kg of rice into its differrent characteristics like aromatic, tasty, suitable for beaten rice and like.

valuation are built upon the input characteristic modeling of the utility maximizing HPM, as originally presented by Griliches (1966), Lancaster (1966) and as adapted further by Ladd and Savannut (1976). Ridker (1967) is the first to use this method on environmental goods for estimating marginal value of air quality in residential areas. The equilibrium is achieved when the variation in price reflects the variation in the attributes under the condition of full information. For estimating the use value given by the consumers attributable to major traits of rice varieties, the farmgate price of different landraces and varieties of rice was regressed with tasty trait, aromatic, suitability for bitten rice (flatened rice used for snacks), good for *latte* and *siroula* (local dishes for special occasions), medicinal uses, used in ceremony, expansion in cooking, good storage, milling percent, Terai area, and main season crop.

VALUATION OF RICE GENETIC DIVERSITY

The sample farmers of 200 households are growing 78 rice verieties altogether. The relative abundance of these varieties is presented in Table 1. BG-1442, Basmati, Sona Masuli and Anadhi are the most popular four varieties grown by more than 20 percent of the farmers. Farmers plant each variety separately on different plots or sometimes in the different parts of the same plot. On average, each farmer is growing 4.62 varieties of rice every year. Owing to the small size of the land holding, each variety on average commands very small area. The precious landraces are unable to compete with other commercially grown modern varieties. These varieties are thriving in the farmers' field only due to their special phenotypic characteristics that are controlled by the respective genes. To protect such genes from extinction, there is a need to understand the value of these genes and make the landraces beneficial to the farmers to stay on the farmers' fields.

The main reasons for very small area under many landraces are that their productivities are low and the prices are not high enough to compensate the lower productivity in comparision to the modern rice varieties (Fig.1). The average gross revenue[1] from the landraces is Rs 19,904 per hectare as against Rs 26,622 from modern varieties (Annex 1 and 2). It is clear that the gross return from many landraces is about one third of the gross return from other competing modern varieties. The landraces are surviving in the field of the farmers only due to their typical characteristics that modern varieties can not fulfill. It shows that the typical landraces with unique useful genes are finding tough replacement challenge from modern rice varieties to survive *in situ*. Some more productive rice landraces like Meghdoot and Basmati appear to be able to compete with modern varieties due to their higher prices, but such varieties need good quality land to produce that limit the farmers to expand their areas. Other many varieties that seem to be less competitive are at the verge of extinction. The policy should either go for *ex situ* conservation or understand the value of these landraces to the society and find market means of conserving them *in situ*.

For the purpose of estimating the value, the society puts on different traits of rice varieties, a hedonic pricing model is fitted with the market price of paddy rice[2]. The phenotypic characteristics like tasty to eat, aromatic, good for latte and siroula (local snacks popular in particular occasions), used in ceremony and medicinal properties are preferred by the consumers. It is hypothesized that for each of these preferred traits, consumers pay certain amount. As the price is taken for fresh harvest of paddy rice, the milling percent (recovery of milled rice) is also a concern for the buyer. It is hypothesized that the higher the milling percent the higher the buyer will pay keeping all other traits

[1] Cost of production of the landraces is not included in the paper as it does not differ much from that of the modern varieties.

[2] The term "paddy rice" in thisw paper connotes unmilled rice. Milling 100 kg of paddy rice produces on an average 63 kg of milled rice. The "milled rice" is generally termed as "rice". The recovery percent from paddy rice to milled rice is called milling percent.

constant. Geographical area plain (Terai) is fitted to catch the fixed effects of hills and plains. It is also hypothesized that the main season paddy rice fetches higher price than the summer season paddy rice. Though some of the traits appear to be not mutually exclusive, they are used separately as long as there is no risk of multicollinearity.

Table 1: Relative abunadance of rice varities

Relative abundance[1] (%)	Name of the modern rice variety	Name of rice landrace
40 to 50	BG-1442 (1)	0
30 to 40	0	Basmati (1)
20 to 30	Sona Masuli (1)	Anadhi (1)
10 to 20	Mansuli, China-4 and Sabitri (3)	Kathe, Anga, Meghdoot, Jetho Budho, Pahele, Sotwa, Rekshali, Ekle, Dhudhraj and Harinkar (10)
Less than 10	Lumle-2, Chaite-1, BGAR-4, Ghaiya -2, Radha-7, Janaki, Radha-9, Barkhe-2, Machhapuchhre, Khumal -4, Chhomrong, Jaya, Biramful*Himali, Ekle hybrid, Ekle*KY, HY-6264, IR-6465, Mansara Hybrid, Sano Gurdi Hybrid, Sano Gurdi * NR, Thulo Gurdi Hybrid and Thulo gurdi*NR (22)	Rate, Kalopatle, Gurdi, Biramful, Chhatraj, Mutmur, Rato Anadi, Bayarni Jhinuwa, Chhote, Jerneli, Mansara, Seto Anadi, Darmali, Madhesi, Manamuri, Natwar, Budho Sigdeli, Nakhisaro, Kaskeli Thude, Gauria, Kathe Gurdi, Ranga, Sokan, Thulo Gurdi, Sathi, Gajale Gurdi, Madhumala, Masula, Philipes, Lamjunge, Deurali, Sano Gurdi, Seto Gurdi, Rato Darmali, Deupure Kathe, Kaskeli Kathe, Bhelasaro, Lahare Gurdi and Bhalu (39)
Total	(27)	(51)

Table 2: Comparision of the yield of and gross revenues from modern varieties and landraces

Gross revenues (Rs/ha)	Modern varieties	Landraces
Over 50,000	Sona Masuli	0
40,000 to 50,000	BG-1442	Meghdoot, Basmati
30,000 to 40,000	BGAR-4, China-4, Mansuli	Harinkar, Chhatraj, Dhudhraj, Bayarni Jhinuwa
20,000 to 30,000	Sabitri, Barkhe-2, Radha-9, Ghaiya -2, Jaya, Chaite-1, Radha-7	Sotwa, Madhumala, Seto Anadi, Biramful, Jetho Budho, Ekle, Gurdi, Rato Anadi, Seto Gurdi, Anadhi, Gauria, Natwar, Mutmur, Pahele, Gajale, Gurdi
10,000 to 20,000	Khumal -4, Masula, Janaki, Lumle-2, Chhomrong	Ranga, Machhapuchhre, Nakhisaro, Kathe Gurdi, Philipes, Darmali, Madhesi, Chhote, Manamuri, Bhalu, Kalopatle, Jerneli, Rato Darmali, Mansara, Anga, Budho Sigdeli, Lamjunge, Rate, Rekshali, Deurali, Kaskeli Thude, Sokan, Kathe, Kaskeli Kathe, Deupure Kathe, Lahare Gurdi
Less than 10,000	0	Sathi, Thulo Gurdi, Bhelasaro, Sano Gurdi

The philosophy behind hedonic pricing model is that nobody pays for a commodity but the people pay for the embedded bundles of utilities of a product. The utilities may or may not be separable. The average price paid by the market to the fresh harvest of paddy rice is Rs 1,034 per quintal ranging from Rs 500 to 2,400. If it is assumed that all the farmers are getting equal market opportunity, the variation in the price is due to the difference in the

[1] The Relative abundance is measured as the percent of the households growing that variety or landrace.

quality, that is, the bundle of traits. The observation used in the model is the landraces and modern varieties grown in each of the sample households.

For each landrace and modern variety the combination of the traits is different and the price fetched is also different. Thus, the total number of the observations in the sample of 200 households is 932.

Table 3: Use value of major traits of rice landraces (n=932)

	Variables	Coefficient[1]	Mean	Unit
1	Price of paddy rice	Dependent	1033.87	Rs/quintal
2	Tasty	49.22**	0.61	dummy
3	Aromatic	292.93***	0.19	dummy
4	Good for latte & siroula	107.61***	0.08	dummy
5	Used in ceremony	130.83***	0.18	dummy
6	Milling percent squared	-0.05***	3931.61	percent
7	Terai area	164.27***	0.48	dummy
8	Main season paddy rice	76.47***	0.92	dummy
9	Year of growing squared	0.02***	850.67	year
10	Non agriculture income	0.14***	82.37	Rs 1000
11	Constant	924.91***		
	F(9, 922)	74.02***		
	Adjusted R^2	0.414		

Source: Household survey 2006.

The results of linear hedonic model fitted over the above data are presented in Table 3 along with the mean value of the variables. The estimates show that the consumers pay Rs 49 per quintal for a tasty trait. This estimated coefficient is 4.76 percent of total price of paddy rice. The estimate is highly significant. It can be inferred that by conserving the landrace with this trait and keeping alive the potential of incorporating this trait to other rice varieties, the potential benefits will come from increasing value of paddy rice production by nearly five percent. Similarly, for the aromatic trait, the consumers are ready to pay nearly Rs 293 per quintal. This is nearly 28 percent of the average price of the paddy rice. If this aromatic trait is lost, the potential financial loss to the society would be 28 percent of the total value of paddy rice produced. This is a huge figure and sufficient to warrant conservation measures. Though the analysis is generalized, there are so many specific traits in the bundle of aromatic rice. Each of such traits is worth conserving. The rice landraces having traits suitable for snacks like *latte* and *siroula* can fetch higher price by Rs 107 per quintal. Similarly, the traits suitable for using in ceremonies are valued higher by Rs 131 than other varieties.

The result shows that the higher the milling percent (squared value) the lower the consumers are willing to pay. Though the result is significant it is very small. This can not be explained under the assumptions of rational consumers and full information. This is because the milling percent is experience good that is not known to the buyers at the time of bidding a price. The farmers in plain region are getting higher price of paddy rice for similar quality as compared to the farmers in hill region. This is due to better transportation and communication facilities in plain areas for better market connectivity. The independent variables explain nearly 41 percent variations in the price of paddy rice.

[1] Note: *** for 1% level of significance, ** for 5% level of significance and * for 10% level of significance.

Fig 1. Productivity of modern varieties and landraces

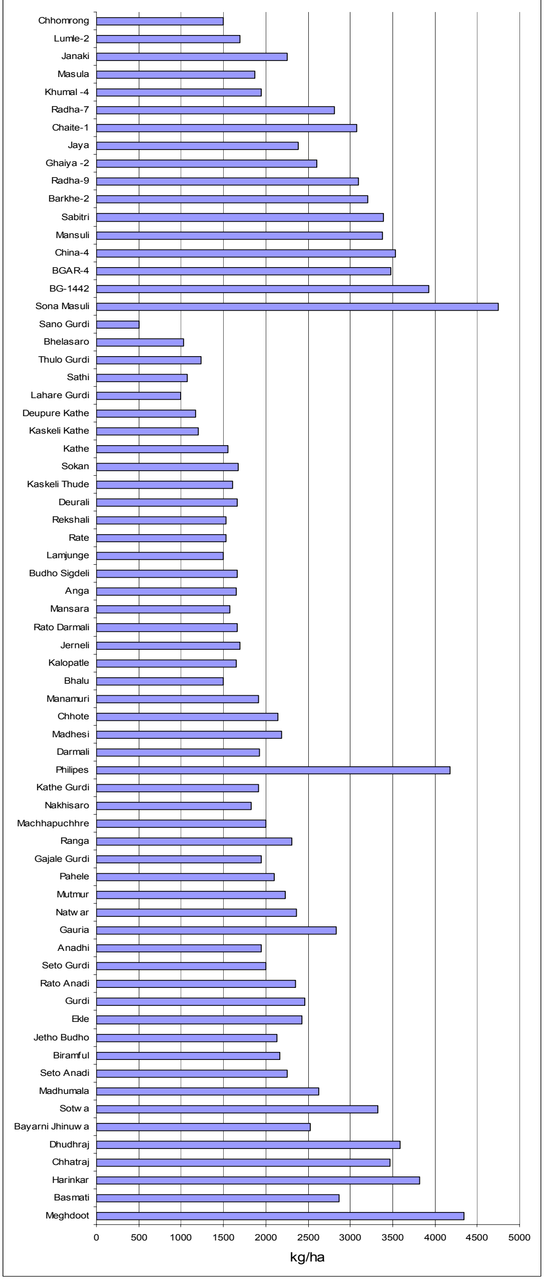
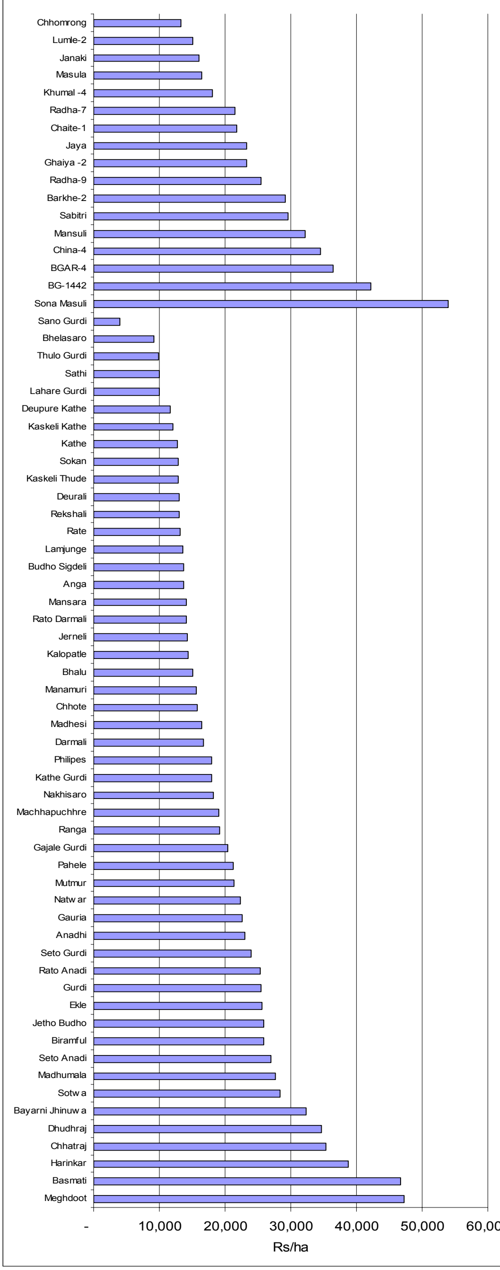


Fig 2. Gross revenues from modern varieties and landraces



Rice in Nepal occupies more than a half share of principal food crops. On an average four million tons of paddy rice is produced every year (GON, 2007) with an estimated value of Rs 41.4 billion using the price estimated from the survey (Rs 10,340 per ton) as the representative at the national level. It means the aromatic traits of rice generate an extra Rs 11 billion per annum for Nepal and tasty traits over two billion rupees. However, there are different landraces with different degree of aroma and different level of taste. A separate study is required to quantify the level of such traits and find the value for each level of aroma and taste. The analysis apportioned the price paid by the consumers to the value given to different traits. It means protecting each of the preferred trait roughly increased value to the society by certain amount. For example, about one fourth of the value of paddy rice produced can be the value of aromatic trait. This includes use values of rice that arise from the actual use of rice. This use value consists of direct use value of the rice consumption by the households and seeds used by the farmers. The non-use value of rice landrace is not included in this analysis.

CONCLUSIONS

The hedonic property valuation analysis apportioned the price paid by the consumers to the value they give to different traits of rice. The study concludes that protecting each of the preferred trait increases the value to the society to a large extent. For instance, the value of the aromatic trait of Basmati or other local landraces can be about one fourth of the value of the paddy rice produced. The aromatic traits of rice have values of about Rs 11 billion and tasty traits over two billion rupees per annum. This estimation of value includes only the use values of the rice that arise from the actual use consisting the direct use value from consumption by the households and option values generated by an individual's willingness to pay to protect the rice landraces for the future use in rice breeding. The gross returns from many landraces are much lower than those from the modern varieties. For both moral and pragmatic reasons, it is essential either to compensate local poor farmers for maintaining low productive rice landraces or make these landraces better income generating than the narrow genetic base modern varieties that are available to them.

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Annex 1: Yield of and gross revenues from modern varieties of rice

	Variety	Frequency	Yield (kg/ha)	Price (Rs/kg)	Gross revenue (Rs/ha)
1	Sona Masuli	59	4,752	11.36	53,984
2	BG-1442	89	3,928	10.74	42,197
3	BGAR-4	7	3,474	10.50	36,487
4	China-4	28	3,537	9.77	34,566
5	Mansuli	29	3,378	9.52	32,154
6	Sabitri	28	3,396	8.73	29,642
7	Barkhe-2	4	3,209	9.09	29,179
8	Radha-9	4	3,096	8.22	25,466
9	Ghaiya -2	7	2,604	8.96	23,332
10	Jaya	2	2,388	9.75	23,284
11	Chaite-1	12	3,069	7.08	21,736
12	Radha-7	6	2,810	7.67	21,559
13	Khumal -4	3	1,944	9.27	18,028
14	Masula	2	1,874	8.78	16,451
15	Janaki	4	2,250	7.15	16,083
16	Lumle-2	18	1,694	8.90	15,088
17	Chhomrong	3	1,500	8.89	13,333
	Average	305	2,877	9.08	26,622

Annex 2: Yield of and gross revenues from landraces of rice

Landraces	Fre-quency	Yield (kg/ha)	Price (Rs/kg)	Gross revenue (Rs/ha)	Landraces	Fre-quency	Yield (kg/ha)	Price (Rs/kg)	Gross revenue (Rs/ha)
Meghdoot	33	4,345	10.86	47,193	Darmali	7	1,929	8.67	16,714
Basmati	75	2,872	16.29	46,780	Madhesi	6	2,183	7.54	16,467
Harinkar	21	3,822	10.15	38,802	Chhote	7	2,143	7.33	15,714
Chhatraj	9	3,467	10.20	35,348	Manamuri	6	1,917	8.13	15,583
Dhudhraj	23	3,585	9.66	34,620	Bhalu	1	1,500	10.00	15,000
Bayarni Jhinuwa	7	2,524	12.78	32,267	Kalopatle	14	1,653	8.69	14,361
Sotwa	28	3,329	8.53	28,406	Jerneli	7	1,693	8.38	14,186
Madhumala	2	2,627	10.55	27,701	Rato Darmali	1	1,667	8.50	14,167
Seto Anadi	7	2,252	12.00	27,020	Mansara	7	1,576	8.91	14,046
Biramful	9	2,167	11.97	25,944	Anga	35	1,653	8.31	13,730
Jetho Budho	31	2,129	12.13	25,840	Budho Sigdeli	6	1,667	8.20	13,667
Ekle	24	2,428	10.55	25,612	Lamjunge	2	1,500	9.00	13,500
Gurdi	10	2,467	10.34	25,500	Rate	19	1,526	8.58	13,096
Rato Anadi	8	2,356	10.77	25,375	Rekshali	27	1,528	8.54	13,051
Seto Gurdi	1	2,000	12.00	24,000	Deurali	2	1,667	7.80	13,000
Anadhi	53	1,945	11.81	22,975	Kaskeli Thude	4	1,604	8.06	12,933
Gauria	3	2,833	8.00	22,667	Sokan	3	1,677	7.64	12,822
Natwar	6	2,367	9.42	22,286	Kathe	37	1,554	8.19	12,734
Mutmur	9	2,228	9.58	21,341	Kaskeli Kathe	1	1,200	10.00	12,000
Pahele	30	2,101	10.10	21,216	Deupure Kathe	1	1,167	10.00	11,667
Gajale Gurdi	2	1,950	10.46	20,400	Lahare Gurdi	1	1,000	10.00	10,000
Ranga	3	2,308	8.31	19,184	Sathi	3	1,075	9.26	9,950
Machhapuchhre	3	2,000	9.50	19,000	Thulo Gurdi	3	1,233	8.00	9,867
Nakhisaro	4	1,828	10.00	18,284	Bhelasaro	1	1,023	9.00	9,211
Kathe Gurdi	3	1,911	9.40	17,956	Sano Gurdi	1	500	8.00	4,000
Philipes	2	4,179	4.29	17,910	Average		2,076	9.50	19,904

COMPARISON OF FARM PRODUCTION AND MARKETING COST AND BENEFIT AMONG SELECTED VEGETABLE POCKETS IN NEPAL

Deepak Mani Pokhrel, PhD[1]

ABSTRACT

In vein of exploring vegetable production and marketing related problems that could have hindered farmers from getting potential benefit, the study evaluates farm performances in selective vegetable pockets of Kabhrepalanchok, Sindhupalchok and Kaski districts. It describes farm strategies on pre and post harvest crop management, explores marketing channels and mechanisms of commodity transfer and price formation and assesses farm benefits of selective crops. Study method is based on exploration of processes and costs of production and marketing following observations and short interviews with local farmers in small groups, local traders in market centers and local informants. Marketing channels are explored, farm profits and shares on wholesale prices explained through cost-benefit assessments and prospects of vegetable production and marketing described.

Key words: Cost-benefit, marketing-channel, Nepal, price-share, production-marketing system, vegetable pockets, mountain

INTRODUCTION

Nepalese agriculture has been confronting low return depriving farmers of their improvement in livelihood. Especially the mountain people who survive by cultivating cereals on mountain slopes, river basins and small valleys to meet their basic needs, due to poor income, frequently suffer from food-deficiency with low affordability for it. As a solution to which, and thereby to reduce farm-poverty, the country, through various plans and policies (NPC, 1995; NPC, 1998; NPC, 2003; NPC, 2007; MOAC, 2004; MOICS, 1992), identified 'vegetable' as one of the leading sub-sectors to harness advantages of agro-ecological diversities and has undertaken vegetable promotion strategy especially in the small holders visualizing comparative advantages of vegetable production and marketing in economic growth and development and thereby poverty reduction. Over the time and commensurate with the national vision, many state agencies including those supported by donors are, in their various capacities, engaged in vegetable production and marketing promotion in the country. However, the goal is not achievable unless a fairly operating marketing system and a market oriented production system are instituted. Because, before venturing on such enterprises, farmers first consider the accruable profit(s) that largely depends on the prices or market operations and conversely market oriented improvements in production mechanism that helps farmers in fetching higher prices.

PROBLEM STATEMENT

It has been a general mention that the farmers, especially vegetable growers, are fetching reasonable price. However, on the ground of higher visible prices in retail markets and without considering farm investments on production processes and intermediaries' costs on commodity transfer at various levels, the farmers claim that they are not sharing fairly on the consumers' prices. The prices available to the farmers could be genuine, when considered low storability, fresh consumption-pattern and high-volume and sophisticated transportation need of vegetable produces that render vegetable marketing a complex business incurring higher costs and risks at traders' level as well (Pokhrel, 2005).

[1] Senior Horticulture Development Officer (MOAC), deepakmpokhrel@yahoo.com.

Elsewhere, studies on agriculture marketing systems revealed several problems to influence farm income and production and marketing decision reached by farmers, which were broadly associated with fragmented and imperfect marketing situations and policy matters. Imperfect marketing refers to non-competitive situation of price formation. Many socioeconomic conditions in part of farmers and overall marketing structure contribute to creating such situation. For example, farmers are generally poor, less educated and socially powerless. Such situations of farmers coupled with seasonal shortfall of cash, non-storability of vegetables at farm condition and poor availability of price information render them weak in market competition. Based on such reasoning and visualizing limited number of middlemen paying low to farm produces, some literatures have mentioned that intermediaries were exploiting farmers (Pradhan, 1998; Shrestha and Shrestha, 2000). Regarding agriculture marketing in Nepal, a general remark had been such that the traders usually tried transferring all sort of price risks to farmers and offered low prices to them by creating monopsonistic situation, debt-ties and cartel (Thapa et al., 1995). However, such things are not studied in view of vegetable production and marketing in Nepal. The traders might have been doing good jobs; they should not be observed as exploiting farmers just by comparing farmers and consumers' prices, and merely based on study of a component in the system. Many components of a marketing system like production and intermediation are equally responsible for a reduction in farm income. Therefore, studying farm performance of vegetable production and marketing from system perspective is very important to know how different components in the system affected it.

Therefore, different aspects of market oriented production and market operation for vegetable crops need to be identified precisely to improve smallholder farm economy. Unless the associated problems are identified and abated, alleviating poverty in the farming communities as envisaged by national development goal would not be possible. Real problems in the system can only be described, when the economy of production mechanism and marketing system for major vegetable products operating in a particular area is evaluated.

On such ground, an evaluation of vegetable production and marketing was carried out in selected pockets in Kabhrepalanchok and Sindhupalchok districts along Arniko Highway and Hemja of Kaski district to analyze vegetable production and marketing system with major focus on cost-benefit and mechanisms of commodity production and transfer, where farmers are, with a fetch of good income from vegetable production, reported improving socio-economic condition in the recent years (DADO, 2006: DADO, 2007a and DADO, 2007b). The farmers in the localities have been growing many vegetables commercially. The details such as how the farmers are successful in commercial vegetable production and how are they disposing the produces and fetching prices are little known to the societies beyond the farming community.

RATIONALE OF THE STUDY

Vegetable production and marketing is gradually emerging as an important sub-sector contributing to gross domestic product (GDP) in Nepal. Agriculture sector contributed about 33 percent to the GDP (MOAC, 2007a) with 14.38 percent (about two-third of total horticultural share) shared by vegetables including potato (MOAC, 2007b). According to an estimate, area under vegetable crops in the recent years is increasing by nearly five percent per annum. In addition, the productivity and accordingly the production show an increasing trend (MOAC, 2007a). Apart from which, vegetable is a potential source of export earnings, rural employment and economic growth (NPC, 1995). In such situations, improving production and marketing efficiencies is only way to sustain local produce in the market. However, the country is not able to harness available market for vegetables, and different factors at production and marketing levels hindering vegetable business are not fully identified and abated.

Studies on vegetable production and marketing to substantiate economic relation between farmers and traders are limited in Nepal. Some rapid market appraisals and national seminars have raised some issues as problems. They observed farmers' poor access to fair prices and marketing support services and policy weakness as major problems (Koirala et al., 1995; Thapa et al., 1995; Partap, 1999; Banskota and Sharma, 1999; Banskota, 1999; AEC/FNCCI/ WI/MOA, 1996; FAO, 1998; MOA, 1998; Chapagain and Phuyal, 2003). However, such articles and seminar papers describing national perspectives of agriculture marketing are not adequately based on empirical information due to lack of micro level studies. Review of the literatures also suggests that farmers' problems are generally ignored during policy formulation due to lack of farm level information. This study addresses such gaps and empirical evidences from such studies help in proper policy formulation and program planning regarding vegetable production and marketing promotion.

CONCEPTUAL FRAMEWORK

Production, in any agribusiness, is a process of creating a commodity (mainly primary product), which is subject to marketing. Marketing, in general, refers to the process of price-decision for a good by seller and buyer together, and market to the place where such decision takes place (Ellis, 1996). Marketing as a process involves many operations in price formation of a commodity such as transfer, value addition and intermediation. A market can be nearly perfect to imperfect depending on buyers and sellers' influence on price formation, and integrated or fragmented depending on availability of transport and communication among the market participants (Hanson, 1982). Marketing system refers to the channel along which commodity passes through a sequence of stages or events, and it varies with commodity and other factors such as distance, infrastructure and producer's awareness (Ellis, 1996). Price signal transmission and physical transmission of the commodities are major functions of marketing; carrying out such by a market depends on number and size of participants, information system and the physical infrastructure. The physical transmission function can further be differentiated in terms of time, space and form dimensions.

For an analysis of an agricultural production-marketing system, different approaches such as structure-conduct-performance, marketing system, institutional, functional, demand projection, marketing mix, value chain and sub sector analysis have been discussed in literatures. Though termed differently, the approaches, to assess efficiency of commodity and information flow along marketing channel, describe market structure, its quality of operation and factors to influence its operation. Literatures on system-based analysis of agricultural production and marketing, especially at micro level, are very rare. Mechanism of production and marketing varies with commodity and locations including other factors as well (Pokhrel, 2005).

Farms, through investment of scarce resources on various inputs and production processes, produce crops of their choice and supply the produces to market. Such actions by farmers for a commodity depend on price signal (demand chain) and physical transmission (supply chain) functions of marketing systems (Ellis, 1996). In a production integrated marketing, such a process of two way transfer is efficient rendering the production system demand-responsive as determined by a number of factors, broadly associated with infrastructure, socioeconomic attributes, policies and institutions (Pokhrel, 2005). Influenced by such factors, the system's operation consequently affects the production and marketing decisions reached by market participants including farmers. Most important, it determines economic benefit (margin) accrued to farmers as an incentive for cultivation of a crop. A fair and high price available to farmer has positive impact on farm production decision, which leads to an expansion of the production program and its improvement at farm level. In contrast, an unfair and low price available to farmer affects farm production decision negatively, and renders him/her reluctant in continuing the production program (Pokhrel, 2005). Therefore, evaluating farm level production expenses and relative profits and prices is very important. A detail analysis of such things involves evaluation of marketing channel and the functions carried out by different components in the production-marketing system. A wider coverage of value-chain and/or marketing components such as intermediation, distribution, storage, processing, consumption and marketing support services, though would be much relevant, was not possible due to time and resource limitations.

MATERIALS AND METHODS

The study was carried out as an exploratory and cross-sectional type seeking answers to 'what' occurs, and 'how' the process operates in a particular segment of society. In such pursuance, the study explored vegetable-based production processes, major cropping patterns followed and marketing channels including structural elements such as types of participants, their roles and behavioral interaction among them. Major stakeholders in the vegetable production and marketing system(s) including mainly the farmers (in small groups of 5-7), the traders and the business associations such as cooperatives and market centers were selected using snowball method and purposive technique of sampling and consulted through focus group discussions and informal interviews during March and April of 2008 (Annex 1). Participatory cost-benefit analyses on production and marketing of major vegetable crops were applied to explain farm profits and shares on wholesale prices. Secondary information on vegetable collection and prices was also collected from District Agriculture Development Offices (DADOs) and market centers where available. Structured checklists were used while interviewing farmers in groups and observing production sites and market centers. The quantitative data thus collected were input and analyzed in spreadsheet of Microsoft Excel such as cost-benefit, and the qualitative data through descriptive approaches such as marketing channel and Strength, Weakness, Opportunity and Threats SWOT analyses.

RESULT AND DISCUSSION

FARM STRATEGY IN COMMODITY PRODUCTION

Scale and quality of production, productivity and pre-marketing farm level management of marketable products are important issues of supply management, which affect price of the products and overall efficiency of the production and marketing system.

All the vegetable pockets considered in this study are situated in mountain slopes or valley land with subtropical to temperate type of climate. Majority of vegetable growing households had below 10 ropani1 size of holding. Hemja Village Development Committee (VDC) of Kaski district is adjoining to Pokhara Sub-Municipality (8-13 km), a tourist center, linked by Pokhara-Baglung road to national transportation network. Having irrigation facility in major area of the VDC, paddy in summer is generally followed by two or three crops of vegetable in succession. The farmers preferred growing especially potato (75 percent farmers cultivated potato in more than 50 percent area), cauliflower, cabbage, tomato and cucumber in order. Tomato followed by two months' fallowing or pole bean in plastic houses2 and, in open field, paddy followed by potato or cauliflower or cabbage then radish or cauliflower or cabbage (relayed) and then followed by cucumber mixed in maize has been major annual pattern of crops. Conscious of consumers' preference, Hemja farmers preferred potato production especially MS-42.3 that produced higher yield and fetched better prices even though the variety is not formally recommended on account of its susceptibility to wart disease. Excluding about 1500 farm households cultivating potato,

[1] Unit of land in the study area 19.66 ropani of land is approximately 1 ha.
[2] There were about 500 plastic houses (2-5/farmer), in major 20*6.5 m^2 in size that varied from 10*5 to 20*15 m^2 in size.

more than 115 farmers were reported in Hemja producing vegetables (DADO, 2007b). The farmers used high yielding varieties like MS-42.3 and Janakdev in potato, Bhaktapure in cucumber and imported hybrid varieties in cabbage, cauliflower and tomato. Because of being near to service center in Hemja and DADO and other service providers in Kaski, the farmers had better access to technology. Seventy-five percent of the households growing potato used, on an average, 20 bags of poultry manure in a ropani of land to fertilize the land. Following which, in case of vegetables and other crops, they used a little farmyard manure (FYM), some fertilizers and limited pesticides. Micronutrients such as borax and molybdenum were used exclusively on cabbage and cauliflower in open field and tomato in plastic houses. However, compared to vegetable pockets in Kabhrepalanchowk, the farmers were observed to use less quantity of fertilizers, micronutrients and pesticide in vegetables, and compared to other crops higher quantity of organic manures on potato and tomato being conscious of heavy use of pesticides suppressing natural predators and thereby increasing insect-pest infestations. A plastic house of 20*6.5 m2 size produced a net farm income of 26-50 thousand rupees annually depending on cultivation practices, varieties and market situation. Planting tomato in the plastic house started right from June and harvesting, started from the end of July ended by April. Because of long crop period, farmers generally used heavy basal dose of FYM and frequent application of fertilizers including micronutrients. Furthermore, the farmers planned tomato plantation in plastic houses to produce major harvests by July, when the supply in market is low and prices are high.

Majority of vegetable pockets in Kabhrepalanchowk and Sindhupalchowk are near to capital city Kathmandu and/or border market in Tibet linked by Arniko Highway. Vegetable farmers in Kabhrepalanchowk mainly produced tomato (in open field) followed by cauliflower, cucumber and long-bean in quantity. A similar trend of crop selection was observed in Sindhupalchowk, where farmers, on scale of production basis, ranked cauliflower, tomato, cabbage, bitter-gourd, long-bean, hot-chili and pole-bean in order. The farmers fetched higher average prices for the crops as compared to others ranking behind (Table 1). The farmers in Kabhrepalanchowk generally cultivated 3-5 ropani of land under vegetable-crops, and they had almost year-round supply of tomato, cauliflower, cabbage and radish and a long duration supply of long-bean, hot-chili and cucumber during summer. Contrasting to Hemja pocket in Kaski, vegetable growers in the area used farmyard manure and higher dose of chemical fertilizers to fertilize vegetable plots and higher dose and more frequent application of pesticides in crop protection. According to local informants, the farmers disposed most of the vegetable products in the


Fig. 1: Plastic houses under preparation for new season crop

local markets along the highway. Nearly 75% of the disposal was, in different way, transported to Kathmandu. Banepa-market, supposed to receive only 35% production from its command area in Kabhrepalanchowk as well as Sindhupalchok annually collected nearly 3,400 tons of vegetables. More than fifty locations along the highway and its link-roads were reported collecting vegetables from hinter areas.

Table 1: Annual collection of fresh-vegetables at *Kabhreli tarkari bazaar*, Banepa

Commodity	Collection (t)	Average price/kg
Tomato	1176	21.9
Cauliflower	624	19.6
Cucumber	450	12.8
Long bean	200	20.1
Hot-chili	190	22.5
Radish	171	6.9
Cabbage	148	8.5
Bitter gourd	146	16.4
Dry onion	110	13.5
Butter bean	59	18.1
Brinjal	58	13.4
Sweet pepper	30	20.2
Bottle-gourd	24	10.1
Total	3386	

Source: *Kabhreli tarkari bazaar*, Banepa

Regarding marketing of farm produces, it is not usual that farmers can sustain price bargain with traders at market centers. Moreover, they are likely to loose bargaining power further if they transport the produces in market centers before price negotiation. Transporting farm produces to the market centers also added costs to the farmers. Therefore, wherever possible, farmers in general were observed to take a strategy of disposing farm products at farm gate (if not road head near to farm) to the collectors in contact, and reducing the scale of crop production (such as cucumber, cabbage and radish) that required farmers to carry up to market centers.

FARMER TO TRADER TRANSFER OF FARM PRODUCTS

The attitude, behavior and decisions by farmers and traders in their transaction through price fixation affect others' activities, and the system's operation. In such view, local system was evaluated to understand how the farmers and traders negotiated prices for farm produces. Fig.2 presents a generalized view of vegetable transfer situations from Hemja (Kaski) and Fig.3 from Kabhrepalanchowk and Sindhupalchok based on farmer and traders' mentions, though constructing a marketing channel required complete follow up and verification of various transactions at every point.

Excluding potato that farmers in Hemja had to store in local condition for sometime to wait for collectors, marketing of vegetable products to collectors took place at farm gate right after harvesting. The farmers had, especially in cases of cabbage and cucumber when collectors were not available, to carry the produces to retail market in Chipledhunga or wholesale market in Shantibanbatika. Based on farm mentions, they disposed 80% of their produces at farm gate and 10% in each of the market centers (Fig.2).

Twenty-one percent of total saleable produces in the farms is sold to local small-scale collectors called doke. Packing the vegetables in doko1, they transported it to Pokhara and sold to consumers in footpath and roadside markets. The traders in wholesale and retail markets had a general remark that the doke's practice (buying at farm gate and selling along roadside and footpath) had been detrimental to their business at the market centers.

Excluding a few of those from local villages, majority of the collectors purchasing vegetables in Kaski were from Dhading. They collected 59% of the farm supplies and transferred 49% to the wholesale market near Bus Park in Pokhara and the rest 10% to Shree

[1] A kind of bamboo basket to carry goods on back

Complex retail market at the city heart. As reported by the wholesale traders in the wholesale market, the area on daily basis supplied nearly 4-5 tons of fresh vegetables to the market that made up 7-10 percentage of total transaction there. However, the supplies from Hemja, as per the traders' remarks, had not been as regular as outside supplies. No visible ducts to storage, export-market and vegetable processing were observed there. Potato, though could be stored in cold storages like elsewhere in Nepal, was not reported there for that the farmers in general stored for sometime in local condition until the collectors purchased and retailed to consumers.

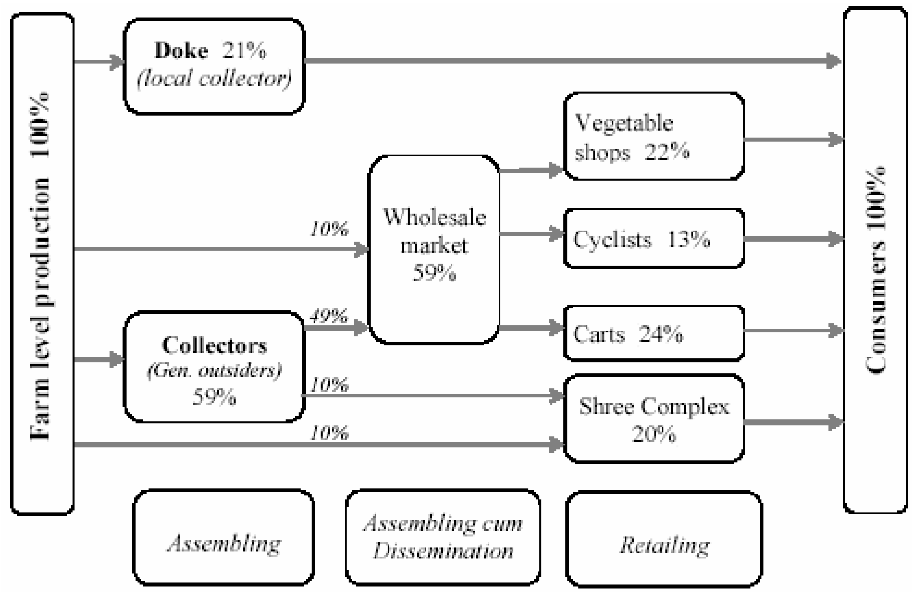

Fig. 2: Vegetable-marketing channels in Hemja (Kaski)

Negotiation system of price formation was observed predominantly to fix on commodity prices as well as, where applicable, commissions between farmer and traders at farm gate as well as wholesale and retail markets. In the system, both farmers and traders bargained for prices and the traders paid the farmers after reaching common agreement. In the commission system that took place only for 10% of transactions, the traders reimbursed the farmers only after complete disposal of the collection with 10% deduction from the sale amount as commission. In both the systems, the traders had a general tradition of delaying payment to farmers upon reasoning cash deficit in hand. As a result, some of the farmers had to approach the traders several times to get payment. The farmers were subject to traders' delay in payment while disposing farm produces in retail and wholesale market centers. Contrasting to which, the farmers on sale to vegetable collectors generally received the amount during transactions (Pokhrel, 2005).

The prices fluctuated much and varied depending on demand and supply situations. As per the farms as well as the traders' mentions, farm gate prices in general differed from the wholesale prices by 2-5 rupees per kilogram depending on such situations and the commodity. The traders had generally better knowledge of price and demand situations in the market. The farmers also tried to know the situations from different means such as even asking to different persons in the market.

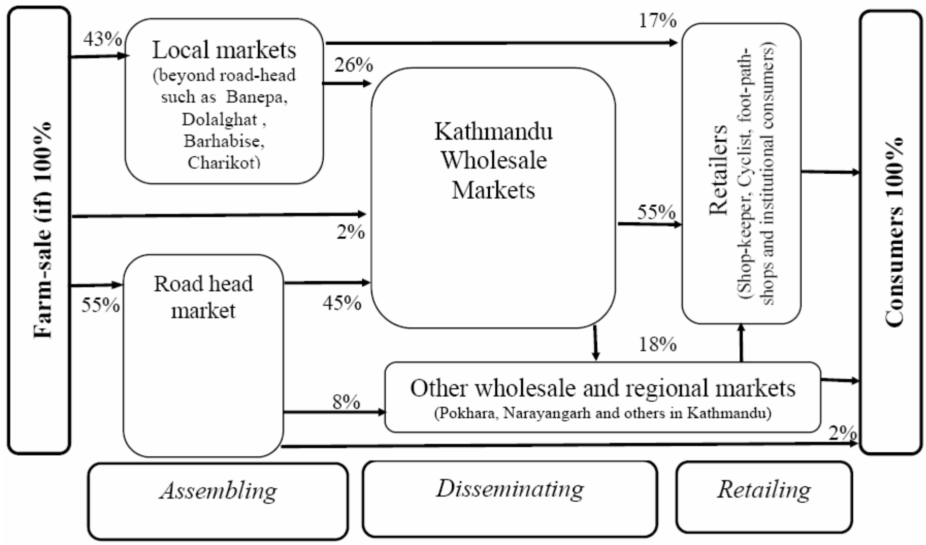

Fig. 3: Vegetable-marketing channels in Kabhrepalanchok and Sindhupalchok

Most of the farmers in Kabhrepalanchowk and Sindhupalchok disposed vegetable products at nearest road-head point[1] to the traders, either the wholesalers coming from wholesale markets in Kathmandu (Kalimati, Baneshwor and Tukucha) or road-head collectors (mainly shopkeepers) or the farmer-collectors from local villages (Fig.3). The wholesalers or the farmer-collectors later transported the products to Kathmandu or other regional markets such as Charikot, Barhabise, Pokhara and Narayangarh or highway local markets such as Banepa and Dolalghat. The wholesalers generally gathered in the road-head markets for vegetable collection. A limited number of farmer-collectors collecting vegetables from neighborhood disposed vegetables in Banepa or via wholesalers in Kathmandu wholesale markets on commission basis. Apart from the small quantity consumed at local market or transferred to other regional market centers, major part of the road-head collection is canalized to Kathmandu.

When the farmers had to dispose in distant market centers, they packed tomato in crates and other vegetables in poly-bags. Majority of them carried the vegetables contained in dokos or gunny bags to road-head where the traders purchasing them weighed and transferred into crates (if tomato) or poly-bags that in general contained 25 kilogram each. After road-head, the vegetables are transported in mini-trucks. Because of perishable nature of the vegetables and lack of safe storage, the farmers, without any say, have to accept the prices offered by the traders. The traders generally offered a price to the farmers based on wholesale prices in Kathmandu, supply situation of the products both in local and wholesale markets and buyers' concentration in the local markets.

FARM COST-BENEFIT OF VEGETABLE PRODUCTION AND MARKETING

Farm production and marketing costs for major vegetables as ranked by farmers were examined by farmers' participatory technique to understand the production system's

[1] such as Banepa, Dhulikhel, Khawa, Kerabari, Tinpiple, Tamaghat, Jirokilo, 54-kilo, Anekot, Mahadevsthan, Baluwa, Shrirampati and Dolalghat in Kabhre and Dolalghat, Chautara, Khandichour, Lamasangu and Barhabise in Sindhupalchowk

performance. The farmers in groups were asked to estimate the costs depending on their practices and experiences, and their net profits based on the prices they generally received. Being aware of farm profitability from a crop that varied with farm-practices, time and location of production and marketing and supply and demand situation in market, only location and time specific assessments of a crop from different groups were averaged. Based on such assessment, the Hemja farmers fetched per ropani annual net income of around 17 thousand rupees from a sequential open field cultivation of cauliflower and cucumber (mixed in maize), and of around 117 thousand rupees from single cropping of tomato in plastic houses. On receiving such profit, the farmers had a total recurring cost of around 10 thousand and 40 thousand rupees respectively (Table 2). Contrasting to which,

Table 2: Farm production and marketing cost and benefit in Hemja (Rs. per ropani)

Particulars	Potato	Cauliflower	Cabbage	Tomato	Cucumber
Production materials					
Poultry manure/FYM	5000.00	1224.50	750.00	4924.24	
Fertilizers and micronutrients	196.60	375.00	375.00	651.52	46.00
Seeds	1250.00	150.00	110.00	757.58	200.00
Pesticides and vitamins	209.00	120.00	600.00	3060.61	155.00
Equipment/ other materials	210.00	210.00	200.00	1363.64	200.00
Plastic house: Polythene				9598.79	
Plastic house: bamboo				4393.94	
Plastic house: Rope & others				663.03	
Labors					
Bullock/ploughman	800.00	600.00	600.00		150.00
Workers including family labour	2100.00	2423.00	2423.00	8181.82	4121.00
Plastic house construction: 20m X 6.5m				6818.18	
Marketing					
Transport by Worker					750.00
Total Expenses	9765.60	5102.50	5058.00	40413.33	4872.00
Net profit	7584.40	9597.50	3442.00	117162.43	7828.00
Cost of production and marketing (Rs/kg)	6.98	5.38	2.74	4.59	6.17

the farmers in Araniko road corridor, though the profits varied with locations and farm-practices, were assessed to fetch per ropani net income of 30 thousand rupees from the vegetables with a total investment of about 25 thousand rupees (Table 3 and 4). In a similar study in vegetable pocket of Dhading, Pokhrel and Thapa (2007) observed vegetable farming and farm profit dependant mainly on location specific factors and alternative cultivation options to the farmers, where per ropani annual farm level net profit of vegetable based cropping system ranged from Rs. 161 to 17,860 (as of 2003 prices). While similar assessment by Singh (2008) showed per ropani net profit ranges from Rs 1,760 to 2,518 with an average investment of Rs. 683 to 1008 respectively in Madhyapradesh of India1. The comparison showed higher economic efficiency of vegetable production in Hemja to fetch attractive income. Hemja farmers were also fetching higher prices (Table 5 and 62) due to a deficit supply in market compared to local demands, nearness to market and freshness of local supply. On such ground, Nepalese farmers in highway corridor with a high rate of investment are fetching attractive income from vegetable production. On an average, a farmer in the groups generally cultivated 3-5 ropani land under vegetable-crops contrasting to that of 28 ropani in India as reported by Singh (2008).

[1] Converted to Nepalese currency (Rs.100 in Indian currency= Rs.160 in Nepalese currency)
[2] Table 5 compares farm gate prices while Table 6 the road-head price to wholesale price.

Table 3: Farm expenditures and profit on vegetable production and marketing, Kabhre (Rs./ropani)

Particulars	Tomato	Long bean	Cauli-flower	Bitter-gourd	Cucum-ber	Hot chili
Production materials						
Compost/FYM	253	253	230	275	253	210
Fertilizers	460	883	405	1075	460	450
Seeds	201	570	600	350	97	350
Pesticides and vitamins	1510	1360	350	1670	1140	1000
Plastic sheet/bags	100	33		150	150	100
Staking poles/wood	2050	2033		2675	800	
Equipment/ other materials	175	100	278	100	100	100
Labors						
Bullock/ploughman	225	225	225	225	188	
Workers including family labour	4703	3775	2525	4038	4080	4500
Marketing						
Packaging/ plastic bags	225	125	220	300	233	350
Transport by Worker	1167	900	1100	1600	1700	100
Transport by vehicle						
Fare for the farmer						
Load/unload/carry						
Total cost	11068	10258	5933	12458	9201	7160
Net profit	9932	7075	18068	4043	3358	17840
Production and marketing cost (Rs/kg)	10.54	11.84	4.94	12.46	8.06	5.73

Vegetable collections from the pockets were directly disseminated to fresh consumption without any intermediary market. Therefore, the marketing channels are very short with limited participants to share on final commodity prices. Beyond production, the farmers in Kabhrepalanchowk and Sindhupalchok bore transportation cost due to wage labors for delivery of produces at road-head market that ranged from Rs 0.80 to 1.20 per kilogram of produce. In addition to which, the farmers had to spend Rs.1.20/kg, if they had to transport the produce beyond nearest road-head point. The wholesalers, for transporting vegetables from road-head, on an average spent Rs 2.25 per kg for packaging material (plastic or crate), transportation and load/unload. Because of time and resource limitations, following a lot of local supply up to wholesale market to observe its real wholesale price was not possible. In view of analyzing farm share on wholesale price, average morning wholesale prices of selective commodities at Kalimati Wholesale Market (Kathmandu) was compared to the road-head market prices of the same commodities at Kabhreli tarkari bazar (Banepa). Such a comparison was made on the price data available for Shrawan of 2063 from both the market centers. The analysis showed that the farmers up on the delivery of vegetable products at road-head, on an average, received about 80% (77-88% in range depending on crops) of the Kalimati wholesale price (Table 5). Conversely, the wholesalers including the farmer-collectors (if any) worked with an average margin of 20%. In addition to which, it was observed in the vegetable marketing system that while weighing each 25 kilogram of vegetable in crate or poly-bag during collection the traders had a discount of almost three kilogram in payment (kachho) as a margin for the containers' weight. In reality and according to the traders, such a margin on the so-called containers helped the traders make up major part of their expenses due to physical damage, weight loss, packing material (poly-bags), load/unload, truck-fare and default payment by retailers. In the context of Madhya Pradesh in India, Singh (2008) observed price-shares by the vegetable-growers as ranging from 59 (colocasia) to 86% (onion). On such ground, price-share by the vegetable farmers and general operation by existing vegetable marketing system in the study area look relatively fair.

Table 4: Farm expenditures and profit on vegetable production and marketing, Sindhu (Rs./ropani)

Particulars	Tomato	Long bean	Cauli-flower	Bitter-gourd	Cucum-ber	Hot chili
Production materials						
Compost/FYM	1300	1025	877	542	1050	600
Fertilizers	750	535	710	738	300	450
Seeds	425	297	296	285	90	375
Pesticides and vitamins	775	667	472	600	1000	300
Plastic sheet/bags	115	0	106	50	100	100
Staking poles/wood	1250	147	0	200	200	
Equipment/ other materials	100	167	100	100	100	100
Labors						
Bullock/ploughman	200	0	200	0		400
Workers including family labour	5800	2400	2846	2700	3000	5600
Marketing						
Packaging/ plastic bags	335	100	166	100		170
Transport by Worker	300	750	412	800	1600	100
Transport by vehicle	600	800	460			200
Fare for the farmer	250		125			250
Load/unload/carry	400		310			200
Total cost	11350	6087	6185	6114	7440	8195
Net profit	11150	6180	4759	7886	5360	4305
Cost of production and marketing (Rs/kg)	7.57	7.94	8.59	7.64	4.65	16.39

Table 5: Share of farmers in Kabhrepalanchok and Sindhupalchok on Kalimati wholesale prices

Price description	Tomato	Long bean	Cauli-flower	Bitter-gourd	Cucum-ber	Hot-chili
Farm sale price (Kabhrepalanchok)						
Minimum (Rs./kg)	8.50	14.67	7.50	6.00	6.67	12.00
Maximum (Rs./kg)	36.00	35.00	37.50	27.50	19.00	27.00
Average (Rs./kg)	18.00	20.67	20.00	16.50	11.00	14.00
Farm sale price (Sindhupalchok)						
Minimum (Rs./kg)	6.00	11.67	7.70	11.50	3.00	15.00
Maximum (Rs./kg)	37.50	23.33	27.00	25.00	15.00	40.00
Average (Rs./kg)	12.50	16.33	15.20	17.50	8.00	25.00
Farm share on price						
Average wholesale price (Rs./kg)	8.00	25.10	32.73	16.19	13.36	31.72
Average road-head price (Rs./kg in Banepa market)	6.15	21.95	27.07	12.90	9.15	23.93
Average price share by the farmers selling at Banepa (% of the wholesale price)	77.71	88.21	83.72	80.64	69.26	77.56

Vegetable production and marketing generally required a high cost for labor (Tables 2, 3 and 4), major part of which is supplied by household members in the farms. Even then, the farms often employed wage labors especially for transporting farm produces to road-head. Frequent uses of pesticides and other agrochemicals also accounted for considerable cost. Based on farm practices, use of the agrochemicals is crucial for high production and production risk management. However, their residues in the produces could deteriorate marketing quality rendering them impossible to reach chemically conscious markets. Compared to vegetable pockets in Kodari highway corridor, the costs due to agrochemicals and, to some extent, labor and marketing are less in Hemja.

Since there were no special price records for Hemja supplies in Pokhara wholesale market, applying daily wholesale price records in an assessment of farm share was also not valid. Therefore, the assessment was based on farmers and traders' mentions. It was observed that farm gate prices of vegetables in Hemja were generally two to five rupees less than wholesale prices in Pokhara depending on commodity and supply situation. Vegetable farmers in Hemja, on an average, received 75% of wholesale price at farm gate. The share could vary from 48-90% (Table 6). Farm share on wholesale price of tomato was much higher than that of other vegetables that the farmers preferred much to cultivate, and that of cabbage, less desired by the farmers to cultivate, was lower (48-70%). Therefore, level of income from different crops governed farmers' choices for investment and production.

Table 6: Share of farmers in Hemja on Pokhara wholesale prices

Price description	Potato	Cauli-flower	Cabbage	Tomato	Cucum-ber	Average
Farm sale price						
Minimum (Rs./kg)	10.00	12.00	2.00	9.00	8.00	
Maximum (Rs./kg)	15.00	19.00	8.00	30.00	25.00	
Average (Rs./kg)	12.40	15.50	4.60	17.90	16.10	
Wholesale (WS) price						
Minimum (Rs./kg)	14.40	17.50	6.60	19.90	19.10	
Maximum (Rs./kg)	17.40	22.50	9.60	24.90	23.10	
Farm share on price						
At minimum WS-price (%)	86	89	70	90	84	84
At maximum WS-price (%)	71	69	48	72	70	66
Average share on WS-price (%)	79	79	59	81	77	75

PROSPECTS OF VEGETABLE PRODUCTION AND MARKETING PROMOTION

Some infrastructure development such as irrigation, blacktopped road and communication linking the areas to national grid of vegetable markets, electricity and diverse physiography with fertile land contributed to efficient vegetable farming. On top of which, the areas being near to major cities of the country have higher advantages of easy access to inputs, technology and other services contributing to lower cost production and marketing. Large number of farmers' groups with considerable saving of financial resources, women as well as educated youths engaged in vegetable production and marketing and some community based organizations (CBOs) committed to providing services in agriculture development are other positive aspects.

However, the vegetable farmers had complains on quality of seed and fertilizer supply, which adversely affected production and its efficiency. The farmers are much concerned on poor quality of seeds and fertilizers available in the market, and have a sense of regret on the state's inability to have control on the quality deteriorations. Potato farmers in Hemja have special concerns with non-availability of sufficient seed-tuber of locally preferred potato variety (MS-42). Owing to a deficit household supply of organic manure required in vegetable production, the farmers bought poultry manure from Chitwan while those in Araniko Highway corridor experienced soil degradation and depleting crop productivity.

Even then, the farmers have been fetching good prices for vegetable because of above described locational strengths. Moreover, growing cities in general and tourism especially in Pokhara are likely to increase demand for vegetables, thereby increasing consumption level and prices available to farmers and creating ground to expand vegetable promotion efforts. Vegetable farming can be income generating in the areas to reduce farm poverty especially in small holders. Provisions for distant supply of the produces would further increase the prices available to the farmers. The areas' potentiality to maintain regular supply of some vegetables such as tomato, cauliflower, cabbage and radish is a visible strength to harness market opportunities. However, some threats identified there such as increasing severity of crop diseases and pest resulting high use of pesticides, fluctuating market prices, frequent bandhas and growing quality concerns of consumers should be addressed properly while planning such development.

Strengths

1. Relatively good infrastructure including irrigation, road, electricity, nearness to market and access to services (inputs and technology)
2. Fertile land suitable for diverse production of vegetables.
3. Growing local and regional markets with improving marketing facilities.
4. Long tradition of the areas on vegetable production and marketing.
5. Empowered women and encouraged youth groups.
6. Local financial savings.

Weaknesses

1. Decreasing supply of organic manure and depleting soil productivity.
2. Lack of appropriate crop varieties and quality seed supply. Poor quality seeds and fertilizers, sometimes led to complete or partial crop failure.
3. Small number of local traders and limited services from local collection centers.
4. Inaccurate weighing, provision for a kachho of almost three kilogram per 25kg packet was not fair to farmers.
5. High cost of plastic house construction.
6. Low price available to relatively distant producers.
7. Price cartel, which has been easier to traders due to cellular phone, regular contact among them and perishability of vegetable products.
8. Decreased vegetable supply during late winter and early summer due to inefficiency of irrigation systems.

Opportunities

1. Relatively good price available to the farmers.
2. Linkages of the areas to national grids of vegetable markets.
3. Availability of land for area expansion under vegetables.
4. Growing tourism and/or nearness to major cities and trans-border market.
5. Increasing affordability of local peoples for vegetables.

Threats

1. High incidence of diseases and pests requiring high use of pesticides leading to high production cost and occasional crop failure.
2. Hailstorm damage of crops and plastic houses.
3. Bird flue havoc likely to constrain manure supply.
4. Highly fluctuating market prices.
5. Frequent bandhas had direct impact on price and quality of vegetable supplies.
6. Youth's emigration in search of better opportunity.
7. Supply of cheaper vegetables from outside.
8. Increasing number of quality conscious consumers.

Fig. 4: SWOT analysis of vegetable production and marketing prospect

CONCLUSION AND RECOMMENDATIONS

Vegetable production and marketing is valued on account of its growing contribution to the national GDP and expanding areas with potentials to export earning, rural employment and poverty reduction. Such potentials of vegetable farming especially in smallholders could be harnessed only through improved performance of production and marketing systems. Some enterprising farmers have been fetching good income from year round cultivation of tomato in plastic houses and two-season cultivation of tomato, long bean, cauliflower, cabbage and cucumber in open field. Conscious of market demands for the local produces and possible price risks and added costs while selling products at market centers, the farmers strategically managed crop production in time of high demand, performed scale production of the crops saleable at farm gate and disposed them at farm gate to collectors in contact. Besides small quantity of farm produces disposed beyond road-head via farmer-collectors on commission basis, the farmers, in major, transacted the produces directly to private traders at road-head through price-negotiation. Local cooperatives and the cooperative-run collection-centers facilitated only in the transaction process. Because of perishability of the produces and lack of proper storage, the farmers have weaker position in price negotiation. Even then the marketing system is observed to perform well as the farms on an average were observed sharing 75% on wholesale prices, considered reasonable based on their feelings and costs involved. On such ground, vegetable farming can be good source of income to reduce farm poverty especially in small holders. Despite the facts, farm supplies are irregular and below quantity demand leaving sufficient rooms for promotion of scale production and marketing improvements. Because of harsh bargain on price and delay on payment by traders, disposing farm produces in wholesale market centers is a matter of price risks to the farmers. In addition to proper addresses of the marketing weaknesses, relevant policies and programs are essential regarding research and development on emerging pest control, suitable crop variety and seed and fertilizer quality control.

Contrasting to the costs incurred in vegetable forcing, the costs due to pesticides is high that would contribute to deterioration of product quality, environment and public health. A high residue of agro-chemical in the produces is likely to hamper their marketability especially when they are to be exported. Use of various agrochemicals such as insecticides, fungicides, hormones and growth regulators in vegetable production is also crucial to maintain high productivity and reduce production risks. On the other hand, promotion of trans-border marketing of vegetables to Tibet would increase prices available to the farmers in Kabhrepalanchok and Sindhupalchok due to proximity. 'Why vegetables produced there are hindered from transferring across the border but a big volume of Chinese products finding easy way to Kathmandu' is not much clear. Such a dilemma in vegetable-based agribusiness promotion in the country calls for appropriate and timely concerns by the policy level.

Some of the genuine problems related to production system such as diseases and pests severities, deteriorating soil environment, lack of year-round irrigation and poor quality of seed and fertilizer materials in the input market hinder vegetable farmers from realizing optimum crop productivity. Likewise, marketing related problems such as fluctuating prices due mainly to frequent bandhas in the recent context, a high weight margin for containers in market centers and poor availability of price information to farmers compared to traders contribute to market imperfectness. Both the types of problems justified areas of future efforts by the state and other agencies working there in production and marketing promotion of vegetables.

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Annex 1a: Vegetable producers' groups/cooperatives interviewed

Janajagriti tarkari utpadak cooperative society, Dhulikhel-6.

1. Kabhreli tarkari bazaar Private Limited, Banepa
2. Pragatishil Multipurpose Coop. Society, Panchkhal.
3. Budhathokidanda vegetable producers' group, Dolalghat-9.
4. Chakradevi off-season vegetable producers' group, Dhulikhel-1, Pakucha.
5. Jagaruk Krishi Klab (Shrijanshil women's multipurpose coop. soc), Shrirampati.
6. Kalika fresh vegetable producers' group, Panchkhal-6.
7. Mahila krishak samuha (Gramin mahila bikas multipurpose coop. soc),Panchkhal-7
8. Airidevi tarkari utpadak sanstha, Hokse-1.
9. Kalleridanda taja tarkari/ kaphi utpadan samuha, Sukute-9,Sindhupalchowk
10. Krishi bikas samiti, Mankha-6, Khandichour.
11. Kalidevi tarkari utpadan samuha, Sangachowk-1, Karkitar, Sindhupalchowk
12. Janajagaran krishak samuha, Sangachowk-7, Bahungaun, Sindhupalchowk
13. Radhakrishna krishak samuha, Sangachowk-7, Jalkini, Sindhupalchowk
14. Machhapuchchhre Famers' Group, Hemja-6, Kaski
15. Kamadhenu Famers' Group, Hemja-6, Kaski
16. Debisthan Famers' Group, Hemja-6, Kaski
17. Gourabsali Famers' Group, Hemja-6, Kaski
18. Bahudhesia Kisan Sahakari, Hemja-6, Kaski

Annex 1b: Road-head and wholesale market centers observed

1. *Kabhreli tarkari bazaar*, Banepa.
2. *Janajagriti tarkari utpadak sankalan kendra*, Dhulikhel-6.
3. *Shramik tarkari tatha phalphool sankalan kendra*, Tamaghat, Panchkhal.
4. *Tarkari sankalan kendra,* Tinpiple, Panchkal.
5. *Tarkari sankalan kendra,* Dolalghat-9
6. Vegetable vendors, Dolalghat.
7. Vegetable vendors, Khandichour
8. Vegetable vendors, Barhabise
9. Wholesale market center, Kalimati, Kathmandu.
10. *Tukucha tarkari bazaar*
11. *Banepa tarkari bazaar*
12. Wholesale market center, Pokhara.
13. *Shri Complex Retail Market, Pokhara*

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SOCIO-ECONOMIC AND ENVIRONMENTAL ASPECTS OF FARMING PRACTICES IN THE PERI-URBAN HINTERLANDS OF NEPAL

Gopal Datt Bhatta, MSc[1] and Werner Doppler, PhD[2]

ABSTRACT

Spatial location of the farm households shapes farming practices and livelihoods of the farmers. Many socio-economic variables have strong spatial relations that would otherwise be missed by data aggregation at household level. Geographic Information System (GIS) provides display and analysis of socio-economic data that may be fundamental for many social scientists to understand socio-economic reality influenced by geographical position of the farm households. Present article aims at integrating socio-economic data into GIS environment to examine spatial relation in the resource availability and use employing spatial and random sampling techniques. Result demonstrates the variation in the socio-economic attributes along the spatial gradient which is mainly related to the infrastructures such as road, market and improved agro-inputs. While households with better access to these infrastructures have tendency to use more agro-chemicals, have larger family, land holding and livestock units, better off-farm opportunities, commercial farming orientation and hence higher family income; opposite is true for the households with poor access to these infrastructures. Peri-urban farmlands, wherever agro-chemicals are applied imprudently, faces the problems of agro-ecological degradation while rural subsistence farming faces the problem of spatial poverty.

Key words: Data integration, GIS, Nepal, peri-urban area, spatial explicit assessment

INTRODUCTION

Rural areas in Nepal face the problem of spatial poverty trap with relatively better agro-ecological domain while peri-urban areas (PUAs) face the problem of agro-ecological degradation due to imprudent use of agro-chemicals particularly in the market oriented vegetable production (Bhatta, 2010). Use of agro-chemicals shows spatial relationship, households with road and market access use more agro-chemicals (Brown, 2003) and such spatial tendency gives rise to various farming practices (Bhatta et al., 2009a). The scientific findings on deleterious effects of excessive use of agro-chemicals on human, animal and the environment health have been reported frequently. While these problems are more acute in the highly intensive vegetable production areas (Bhatta et al., 2009b), organic or sustainable family farms enjoy better agro-ecological conditions (Sharma, 2006). Because of higher population pressure and less farm land availability along with efficient input-output marketing, peri-urban areas (PUAs) face acute problem of environmental degradation.

Urban areas in Nepal including Kathmandu valley have huge daily demand of the perishable commodities like vegetables and hence most of the farmers around urban and peri-urban areas are going towards commercial production of the vegetables (Bhatta, 2009). Close to 23% of the vegetables consumed in Kathmandu are produced by poor farmers in urban and peri-urban agricultures. This figure can be improved to 76% by improving farming practices and constructing a road networking system from the peri-urban to urban area (Pradhan and Parera, 2005). Most of the poor farmers in the PUAs make their living by selling vegetables in the market. This also contributes toward self-reliance in food and maintains the green

[1] Agriculture, Scientific Staff and Ph. D. Scholar at Ins. of Agri. Eco. , Uni.versity of Hohenheim, Germany, Email: bhattagopal@gmail.com

[2] Professor at Ins. of Agri. Eco. , Uni. of Hohenheim, Germany,, Email: doppler@uni-hohenheim.de

space in the Valley. Unfortunately, farmers around the hinterlands have been transforming their lands from subsistence based food production towards commercial farming of vegetables using agro-chemicals leading to the environmental cost of farming practice.

Realizing the negative repercussion of the external input based farming, some of the farmers nearby urban areas started following organic farming. The rural area, some 20-30 km away from Kathmandu metropolis, however, is dominantly occupied with subsistence farming more precisely considered to be organic by neglect. Variation in farming practices followed by the farmers in different spatial locations produce different socio-economic and environmental implications (Bhatta et al., 2009a). Recently there has been a tremendous increase in the utilization of GIS into analysis of socio-economic phenomena (Bowers and Hirschfield, 1999; Joshi et al., 1999; Schreier and Brown, 2001; Evans and Moran, 2002; KC, 2005; Codjoe, 2007; Bhatta et al., 2009a). Collecting socio-economic data in the spatial context and maintaining the original location specific information could reveal patterns in the data, which would otherwise be missed (Brown, 2003).

Socio-economic differentiation along the spatial gradient arises owing to the distances between fields, markets, access to information and location for off-farm opportunities. Biophysical settings of the resources and the socio-economic characteristics of the farm families can be influenced by their spatial position (KC, 2005). Location specific information for an entire region is best handled by computerized information system with the use of GIS. GIS software provides tools for the display and analysis of spatial information (Starr and Estes, 1990). It stores geographic data, retrieves and combines this data to create new representation of geographic space, provides tools for spatial analysis and performs simulations to help expert users organize their work in many areas including transportation, agriculture development and environmental information system (Rigaux et al., 2002). This research is based on the concept of spatial assessment of farm practices and socio-economic attributes of farm families by integrating micro-survey in GIS environment and evaluating these aspects spatially in the regional level.

METHODOLOGY

THE STUDY AREA

Based on the research objectives, study area lying in Lalitpur and Bhaktapur districts in the mid hill of Nepal was selected (Fig.1) because of following reasons.

- This area since historic time has been dominated by farming activity.
- Vegetable production is commercialized and a large chunk of vegetable in the Kathmandu valley has been supplied by the farmers of this area.
- Though not too far in terms of distance from capital city, some villages within the districts are less developed with unique rural setting and some villages are quite prosperous with modest accessibility and urban flavour.
- Spatial variation is quite high in the selected areas and different farming practices have been performed by the farmers in different locations.

SAMPLING PROCEDURE

Before taking samples, three homogenous farming zones were identified viz., subsistence farming in the rural area, commercial inorganic farming in the North West and [1]smallholder organic farming in the North East of the peri-urban areas of Lalitpur and Bhaktapur districts. Through spatial sampling, a total of 60 and 35 farm households were selected

[1] Many farms in the smallholder organic zone have a two-tier production system: organic for income generating crops like vegetables mostly in the kitchen garden and conventional for subsistence production of food crops.

respectively from subsistence and commercial inorganic farming zones while 35 farm households from smallholder organic farming zone were selected by employing simple random sampling method. Spatial sampling was employed since information on the number of households settled down in the study areas was not available and at the same time wide physical coverage and scattered residence. Spatial sampling is based on the concept of spatial dependency which relies on the principle of proximity of locations to one another. Closer locations to one another are expected to have more similar values than those farther away (Tobler, 1970). The selection of this method was based on the principle that all households settled down in the study area were surveyed.

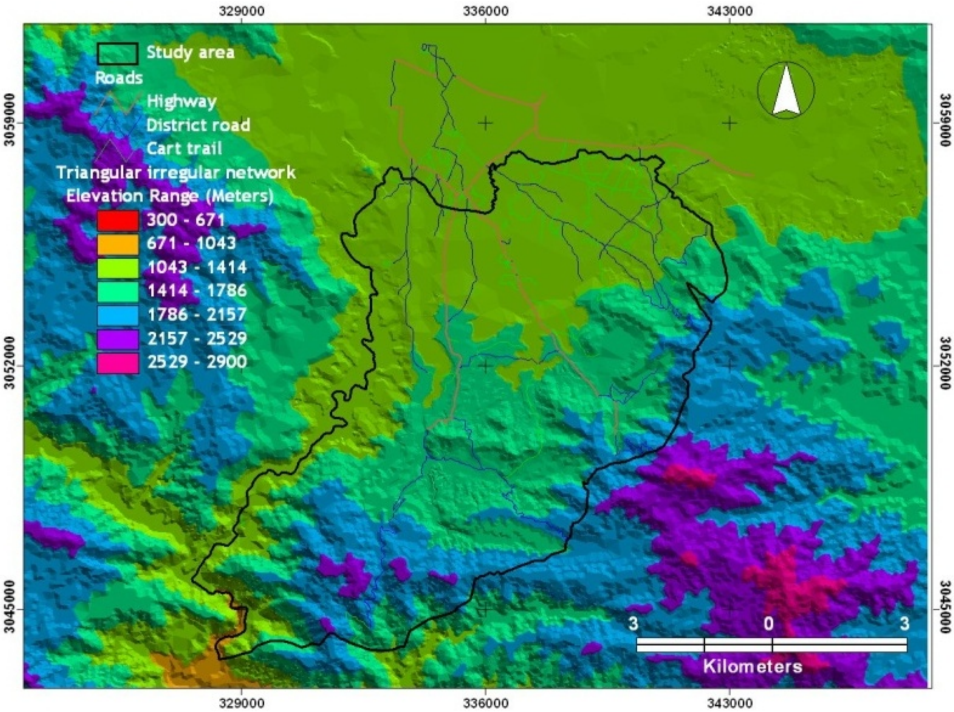


Fig. 1: Study area showing different farming zones and sampled household location at different altitudinal range indicated by Digital

DATA COLLECTION

Socio-economic data were collected using structured questionnaire devised after pre-testing and administered through personal interview. Different analogue maps were purchased from Nepal Department of Survey and baseline GIS data for the study area was prepared using such maps. These maps cover roads, rivers and streams, settlements, administrative boundary, contour lines (100 m spacing) and elevations. Global Position System (GPS) was used to locate the household spatially.

DATA INTEGRATION AND SPATIAL DEPENDENCY

The interdependencies between the farming populations and their spatial attributes can be determined through the combination of farming systems methodology (Doppler et al., 2009) which is complemented by information extracted from geographical sources (KC, 2005). Relevant socio-economic data were combined with the spatial data to find the geographical influence on farming systems development. GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for analyzing the data (Star and Estes, 1990).

The strength of GIS lies in its ability to integrate different types of data into a common spatial platform. This information should present both opportunities and constraints for the decision makers (Ghafari et al., 2000). The ability of GIS to integrate maps and databases, using the geography as the common feature has been extremely effective in the context of agriculture development and resource management. The integration of data provides the ability to answer complex spatial questions that could not be answered otherwise (Buckley, 1997; Brown 2003). For linking socio-economic data with GIS, geographic locations of the sampled households was taken during field survey using GPS. After linking the GPS receiver to a computer, the recorded data were exported into Arc View 3.3. GIS software has the capability to deal with these "many-to-one" relationships, as well as the more common "one-to-one" relationships (Walsh et al., 2004). A common key field using household number was made for point attribute table in GIS and the survey databank. Once a linking field, known as the *primary key,* has been set up with household number, data were integrated and a relational database was obtained. Once data were integrated, they were subjected to spatial autocorrelation (SAC) and those variables confirming strong spatial dependency were finally used for spatial interpolation (Fig.2).

There are two popular indices for measuring SAC in a point distribution: Geary's Ratio and Moran's/both of which measures spatial dependency for interval or ratio data (Lee and Wong, 2001). Both Geary's Ratio and Moran's/combine the two measures for attribute similarity and location proximity into a single index of $\sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}w_{ij}$. It is used as the basis of formulating both indices. In both cases, the SAC is proportional to the weighted similarity of attributes of points which could be expressed as (Lee and Wong, 2001):

$$\text{SAC} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}w_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \qquad (1)$$

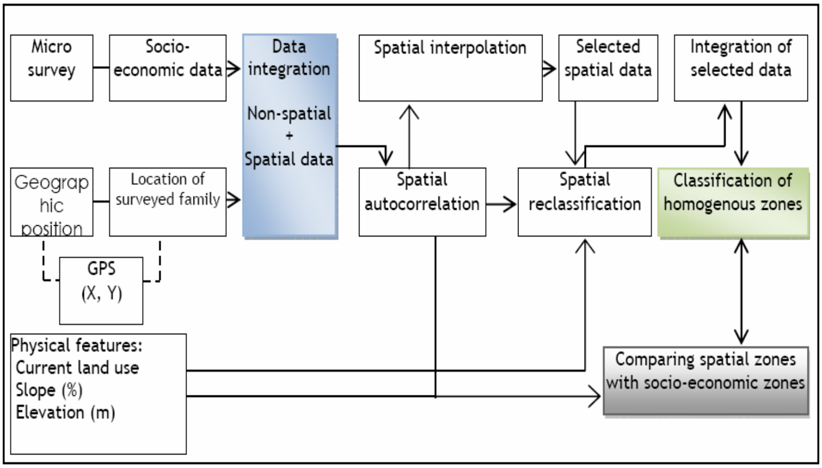


Fig. 2: Integration of socio-economic and biophysical data in GIS environment and process of spatial zoning (Modified from Bhatta et al., 2009a)

Where, cij: similarity of point i's and point j's attributes; wij: proximity of point i's and point j's locations with wij= 0 for all points; xi: the value of the attribute of interest for point i, and n: number of points in the point distribution

Fig.2 depicts the simplified flow diagram of all the steps of data integration into GIS environment. Only selected socio-economic variables were integrated in the GIS. Physical aspects such as land use, slope map and elevation were not analyzed spatially in this paper but nevertheless they crop up in the discussion. Most of the variables interpolated in the results and discussion section show strong spatial dependency.

SPATIAL INTERPOLATION

Spatial interpolation estimate the variables at unobserved locations in geo-space based on the values at observed locations (Zhang and Goodchild, 2002) thus it extrapolates a density estimate from individual data points. Although interpolation results are valid within the convex hull described by the sample locations, there is no way of confirming the true values of the field away from the control points so it is called a type of spatial prediction (O'Sullivan and Unwin, 2003). The principle that underlies all spatial interpolation is the Tobler Law- points which are close together in space tend to have similar value attributes. Basic methods include inverse distance weighting (IDW), spline, kriging and trend interpolation (Naoum and Tsanis, 2004). This study employed IDW which is one of the oldest and simplest approaches and is thus perhaps the most readily available method (Longley et al., 2004). IDW is based on the weights, which are inversely proportional to the square of the distance from the centre of the zone of interest (Kemp, 2008). Thus points closer to the location of estimation are weighted greater than those farther away. Output grid surfaces were created in which value of each cell (25 meter size) was calculated considering the values of 12 neighboring sample points and their distance to the point of estimation. A linear trend in the sample data was assumed for the model.

IDW method has been explained using Fig.3. Graphically, + is assumed to be the point of interest, xi (*) are the points where measurements were taken in which i runs from 1 to n, if there are n data points (Fig.3), z(x) denotes the unknown value and known measurements as i a weight di, which will be evaluated based on the distance from xi to x. Then the weighted average computed at x is:

$$Z(x) = \sum_i w_i x_i / \sum_i w_i \quad \text{..........(2)} \qquad wi = {}^{1}/_{d^2} \quad \text{............(3)}$$

There are various ways of defining the weights, but the option most often employed is to compute them as the inverse of squares of distances which means that the weight given to a point drops by a factor of four when the distance to the point doubles.

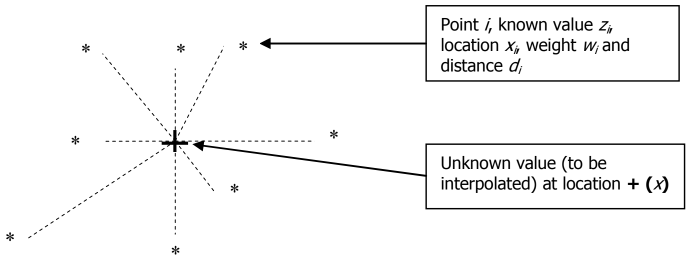


Fig. 3: Notation used in the equations in defining spatial interpolation (Source: Longley et al., 2004)

DATA ANALYSIS

Descriptive statistical methods like means and confidence interval of means were employed. Mann-Whitney test was used for those sets of data which violated assumption of normality while ANOVA was used for normally distributed data. Confidence interval was fixed at 95%. The descriptive statistical analysis along with parametric and non parametric tests for groups was done using SPSS 17.0. Pictorial presentation was done using SigmaPlot 10.0. Arc View 3.3 and Arc GIS 9.2 were employed for spatial explicit analysis.

RESULTS AND DISCUSSION

SOCIO-ECONOMIC ATTRIBUTES

This section illustrates the socio-economic characteristics of the farm families mainly family size, education, labour availability, land holding, livestock units and family income in different farming areas and along the spatial gradient.

FAMILY SIZE

The results show that average family size is 7.04 in subsistence farming, 5.58 in commercial inorganic farming and 5.86 in organic vegetable farming (Fig.4). In the national level, average family size is 5.4 (CBS, 2007) while it is 5.36 in rural areas (CBS, 2005), 5.47 in Bhaktapur district and 4.9 in Lalitpur district. The results from Mann Whitney test show that there is significantly higher family size in subsistence based farming as compared to others while agro-chemical based and smallholder organic zones are on a par. The reason of higher family size in rural area is attributable to lower level of education and lack of awareness about family planning (CBS, 2005) and also the need of more family members for farm and household works.

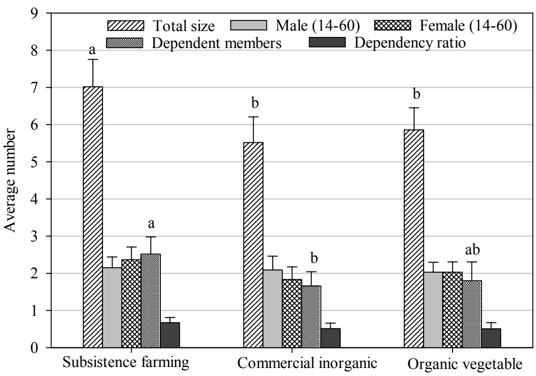


Fig. 4: Distribution of family composition in different farming zones, 2008

Note: Error bar represents standard error of mean (SEm) and similar bars with identical letters are not significantly different between the group at 0.05 level of probability according to the Mann-Whitney test

Higher dependency ratio, a measure of the portion of a population which is composed of dependents (who are too young or too old to work), is of concern since dependents do not contribute economically but share economic resources of the household (Blair, 2007). Under the circumstances of extreme limitations of such resources, an elevated dependency ratio would obviously exacerbate poverty. In the national level, dependency percentage is 77.23 while in rural areas it goes as high as 94.90% (CBS, 2007). Dependency ratio, albeit higher in the subsistence farming, is not significantly different from others. Large family size coupled with higher dependency ratio in the rural subsistence area brings the lower level of living standard as population has been increasing and resources have been degrading leading to demand of more food from the external source.

The results of the spatial distribution of family size observed using GIS methodology through interpolation of micro level information demonstrate the variation of family size along the spatial gradient (Fig.5). It is seen that higher family size is found in the less accessible area where subsistence farming predominates and family size starts declining towards accessible zones. Spatial variation in family size is mainly due to the availability of infrastructures, awareness and literacy status of the family members.

EDUCATIONAL STATUS

Education is one of the preconditions for development. Education grooms the mind and makes it receptive to technological innovation (Ayandiji et al., 2009). Indictors of economic well being such as farm productivity and income is related to educational affluence of the adults in the family (Brown, 2003). The empirical results show that the educational status of the farmers in the study area is better in urban fringe as compared to the peri-urban fringe (Fig.6). Family members with college level of education differ significantly between the groups. The lower level of education in subsistence group is due to less access to educational institution, inability to afford for higher education generally available in the city cores and requirements of more labor force in household and farm activities. Lower level of education in subsistence farming area might lead to poor receptivity of innovative production practices. Family members with low level of education feel difficulty in understanding technological complexity and the benefit from new technology.

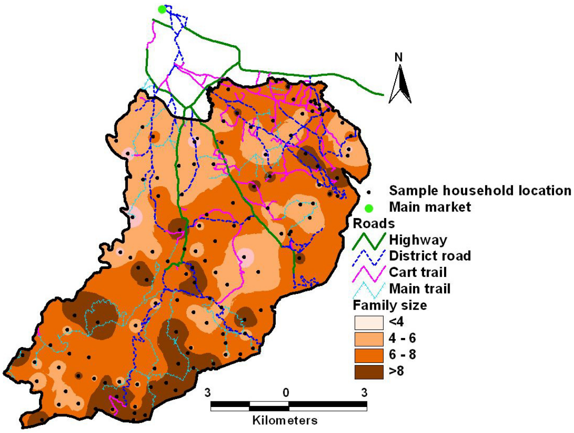


Fig. 5: Spatial distribution of family size along the spatial gradient

FAMILY LABOUR FORCE

Mean family labour for household work is significantly higher in smallholder organic group as compared to commercial inorganic farming and is on a par with that of subsistence group. Contrastingly the mean family labour for farm work is significantly higher in rural area as compared to that in the peri-urban areas (Table 1). Higher number of males and females are involved in off-farm activities in smallholder organic group which is basically due to higher level of education coupled with availability of off-farm opportunities nearby and tendency of both males and females to be economically independent.

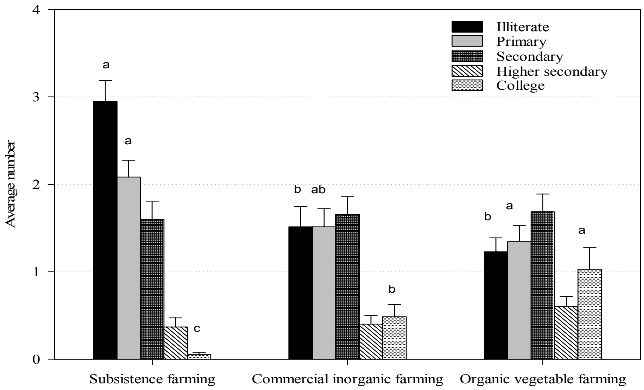


Fig. 6: Educational status of the family members by study zones, 2008

Note: Error bar represents standard error of mean (SEm) and similar bars with identical letters are not significantly different between the group at 0.05 level of probability according to the Mann-Whitney test.

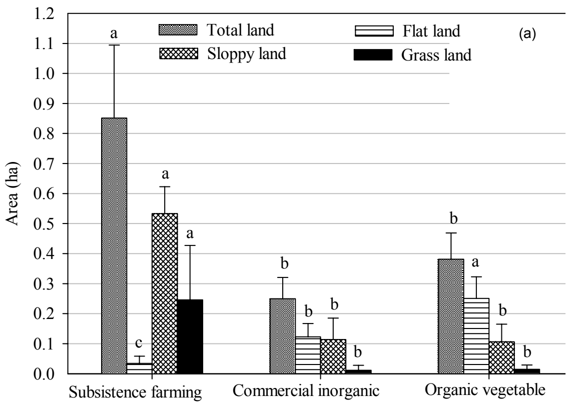
Number of family members involved in own enterprise becomes lower in relatively less accessible area. In contrast, number of family members as labourers is higher in the subsistence farming. Requirements of more farm laborers, unavailability of the off-farm opportunities, less education and remoteness are all contributing towards this. Involvement of more members as farm labors means less income as wage rate is meager leading to poor living standards of the farm families in the remote areas.

Table 1: Mean family labor in farm, household and off-farm activities by study zones

Labour capacity	Subsistence farming(n= 60)	Commercial inorganic (n= 35)	Smallholder organic (n=35)
Household work	2.97^{ab} (±0.30)	2.49^{b} (±0.36)	3.37^{a} (±0.51)
Farm work	3.70^{a} (±0.33)	3.00^{b} (±0.44)	3.50^{ab} (±0.46)
Males in off-farm work	0.97 (±0.22)	0.83 (±0.28)	1.20 (±0.31)
Females in off-farm work	0.19^{b} (±0.19)	0.54^{b} (±0.26)	0.77^{a} (±0.25)
Total off-farm work	1.43 (±0.34)	1.37 (±0.43)	1.97 (±0.48)
Own enterprise	0.18^{b} (±0.14)	0.23^{b} (±0.19)	0.54^{a} (±0.29)
Salaried work	0.78^{b} (±0.23)	0.89^{b} (±0.29)	1.29^{a} (±0.35)
Laborers	0.47 (±0.24)	0.26 (±0.21)	0.17 (±0.58)

Note: Figures in parentheses are 95% confidence interval of the mean; Letters in the superscript show the significant difference between groups at 0.05 level of probability according to the Mann-Whitney test and values with similar letters are not significant

LAND AREA AVAILABILITY



Quality and quantity of land availability determine the living standard of farm families. Moreover, type of crops grown on it, productivity and market value of the produce largely shapes the family's living standards. The results show that average land holding is substantially higher in the subsistence farming followed by the smallholder organic farming (Fig.7a). Although land availability in rural area is higher, production potential of land is lower. Land in the urban area is very inelastic in supply and it has huge economic value.

Fig. 7a: Average land area (ha) under different types of land.

Note: Error bar represents standard error of mean (SEm) and similar bars with identical letters are not significantly different between the group at 0.05 level of probability according to the Mann-Whitney test.

Average land holding size in the Kathmandu Valley is 0.26 ha (CBS, 2003) while it is 0.25, 0.31 and 0.23 ha respectively in Kathmandu, Lalitpur and Bhakapur districts and these values are quite smaller against average land holding size in Nepal which is 0.80 ha (CBS, 2006). Average land holding per family in the subsistence area is almost equal to the national average while other two zones have land size almost equal to that of Kathmandu valley. Significantly higher area under maize is found under subsistence farming zone. This is obvious because most of the land is sloppy and maize is most important food and feed crop in this zone. Most of the lands are rainfed in which rice could not be grown successfully. Similar to this is the area covered by mustard and legumes. Significantly higher area under different kinds of vegetables is found in smallholder organic zone as compared to the subsistence farming and former is on a par to commercial inorganic farming (Table 7b). Farmers in the subsistence farming produce vegetables in kitchen garden mainly for home consumption. Farmers nearby market centre have tendency to grow vegetables commercially and derive income. This is the reason why there is more area under vegetables in peri-urban hinterlands.

Flat land availability is significantly higher in the smallholder organic area as compared to others while sloppy land (bari land), forest and grazing land are significantly higher in the subsistence farming zone.

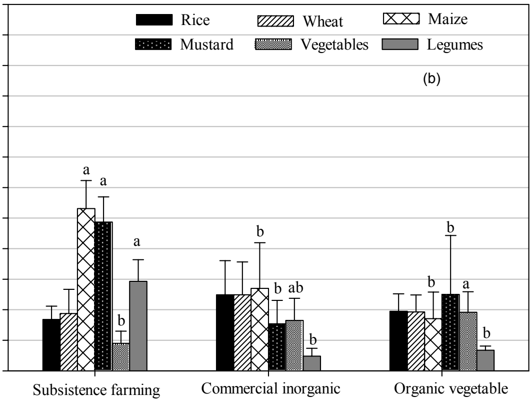


Fig. 7b: Average land area (ha) under different crops.

Note: Error bar represents standard error of mean (SEm) and similar bars with identical letters are not significantly different between the group at 0.05 level of probability according to the Mann-Whitney test.

Food crop area, which includes the area of rice, wheat, maize, potato, buckwheat, mustard and some minor food crops, illustrates the conspicuous pattern along the spatial gradient (Fig.8). Households with poor access to infrastructures have larger holdings and more reliant on subsistence agriculture. Households with road access have smaller landholdings and are more reliant on off-farm employment to meet their families' needs. Brown (2003) noted similar spatial tendency of landholdings in mid hill of Nepal. In the accessible area of Kathmandu valley, land is extremely expensive and it has alternative use for settlement. Therefore people would not like to follow agriculture but would be interested to earn huge money by selling smaller parcels.

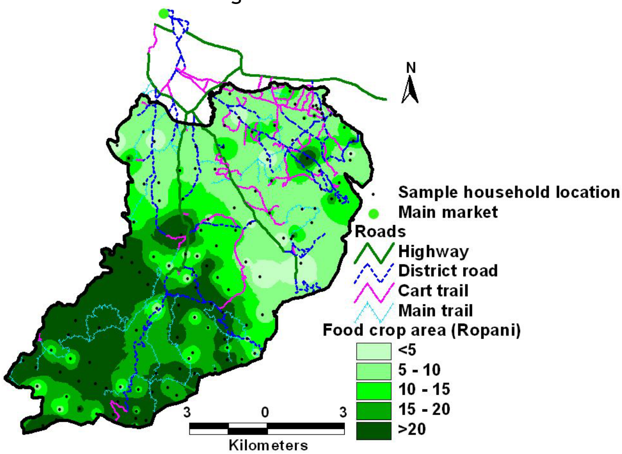


Fig. 8: Spatial distribution of food crops area (interpolation of the point based data)

TROPICAL LIVESTOCK UNIT

Livestock unit measured as the number of animals per farm has an inherent weakness in that as it ignores species and age groups (Katwijukye, 2005). Therefore, the available animal units in the study area are expressed in standardized term called Tropical Livestock Unit (TLU). This parameter is adopted because it allows pooling together animals of different age group and species and gives a relative figure for computation (Kaburanyaga, 2007). Spatial distribution of TLU shows clear variation in the space. Clustering of higher TLU is found in the rural areas and it goes on decreasing from remote to urban areas (Fig.9). In urban areas, generally buffaloes are not reared and some farmers do have few units of poultry generally for home consumption. The reverse is true in remote area where mostly farmer rears cow, buffaloes and goats for market as well as for home consumption and poultry for home consumption. Integration of livestock with agriculture and forest is one of the fundamental aspects of sustainability of the rural farming.

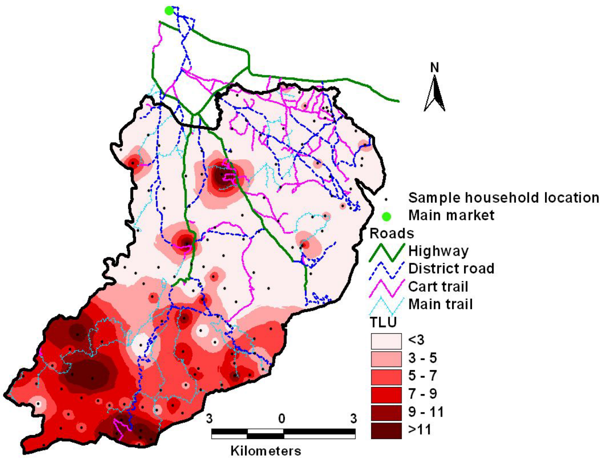


Fig. 9: Spatial distribution of the livestock units in terms of TLU

FAMILY INCOME

Family income was calculated by considering revenues and expenses of all farm activities, off-farm income and income from other sources. Spatial clusters of family incomes are found in the study area. It is relatively lower along the higher altitudinal gradient and it becomes higher in the flat land nearby urban centres (Fig.10). The higher family income towards urban and peri-urban areas is basically due to more off-farm income. Accessibilities to the urban amenities along with the availability of the off-farm opportunities bring higher level of income in the urban areas. Rural areas mainly depends on farm income and because of subsistence mode of production, farm income is also lower in the rural area. Lower farm income, lack of off-farm opportunities along with relative inaccessibility put rural farmers under the spatial poverty trap (Bhatta, 2010).

ENVIRONMENTAL ASPECTS OF FARM PRACTICES

Overall response of the farmers shows declining that there has been a trend in the crop yield irrespective of the production zones (Table 2). Most of the farmers asserted that organic farming is the key for restoring fertility. Most of the smallholder organic growers after realizing the negative repercussion of inorganic farming shifted to this practice of production. Farmers in the commercial inorganic zone experiences negative repercussion of agro-chemicals on the environment. The use of agro-chemicals particularly in the market based vegetable production in this zone is imprudent. Farmers who own livestock apply the manure along with the inorganic fertilizers while those don't own livestock solely depends on inorganic fertilizers as the source of nutrients which is detrimental for the edaphic environment. Although the upward trend in yield of rice-wheat cropping pattern has been maintained over the two decades in the inorganic farming zone, the rate of increase is slackening, largely because of deteriorating soil fertility and the high incidence of pests and diseases associated with monoculture.

Table 2: Yield reduction in farm (% of the respondents)

Yield reduction	Subsistence farming (n=60)	Commercial inorganic (n=35)	Organic vegetable (n=35)
Yes	83.3	62.9	85.7
No	16.7	37.1	14.3

Most of the farmers in organic and commercial inorganic farming experience sharp declination in the yield of rice-wheat cropping pattern whilst farmers of subsistence farming zone experience the yield declination of maize-mustard cropping pattern in which mustard yield has been declining substantially over the last few years owing principally to degrading soil fertility, disease and pest infestations and heavy wind which causes erosion of available nutrients from the surface. In the area where urea fertilizer has been applied constantly without considering soil's contribution and its unbalanced use has led to deficiency of micro-nutrients such as sulphur. Main limiting factors of yield declination are lack of irrigation, unbalanced use of agro-chemicals especially urea and pesticides, soil erosion in sloppy land, disease and pest infestation and lack of manure among others (Fig.11). Principal reasons of yield declination in subsistence farming are lack of irrigation and effect of diseases and pest. Among different diseases, maize blight is the severe disease of maize while aphid is the main pest of mustard. Farmers have also noted the problem of unbalanced use of agro-chemicals which are generally used in vegetables.

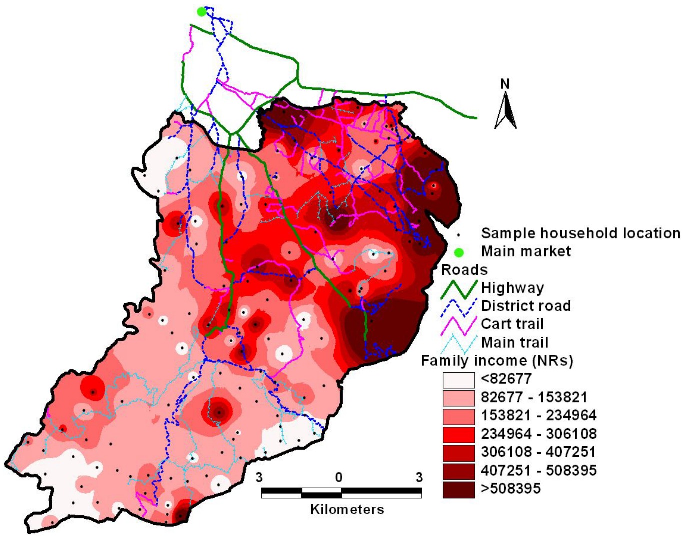


Fig. 10: Spatial distribution of family income (NRs) in the study area, 2008

Overuse of agro-chemicals such as urea nitrogen and pesticides in food and vegetable crops is the main limiting factor in commercial inorganic farming. Farmers in this region are fully dependent on inorganic fertilizers and they give less credence to the farm manure. In addition, farmers, with the hope of getting high yield in short period of time, apply huge amount of pesticides for controlling pests and diseases. Therefore, unbalanced use of agro-chemicals is one of the key environmental issues in this area.

Disease and pest is becoming main reason for declining yield in the smallholder organic farming as most of the farmers produce organically in which they apply local materials specifically botanicals to control pest and disease which are not as efficient as pesticides. Henceforth farmers have to incur a huge loss of the produce each year. Along with this is the unbalanced use of agro-chemicals which is still being practiced by some farmers. Similar to commercial inorganic farming zone, mostly farmers do not own livestock and therefore, farmers have to depend on others for the supply of required amount of organic manure for the crops. The main sources of nutrient are farm manure, poultry manure, cakes and kitchen waste among others.

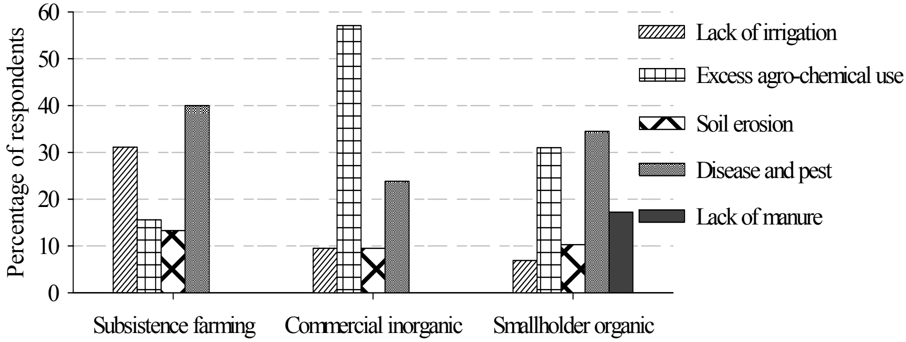


Fig. 11: Reasons of yield declination in different farming areas

Constraints of production practices identified by farmers in different areas at household and in regional levels provide an interesting example of the relevance of maintaining spatial integrity in socio-economic data. Farmers in the accessible commercial vegetable production area identified problem of excessive use of agro-chemicals followed by disease and pest as immediate constraints faced by farming households. When examined spatially, it is clear that both issues are relevant but in different spatial locations. Disease and pest is most pronounced constraint in the rural areas with relative inaccessibility and also in organic production area while issue of agro-chemicals is imprudent in the intensive inorganic based farming areas.

CONCLUSION

Maintaining spatial integrity in socio-economic data collection, analysis and presentation permits a deeper understanding of socio-economic interactions than traditional methods used by most of the social scientists. Farming sector and its actors are much influenced by the spatial variation because of the need to stay contact with the market and other services. This is one of the main reasons why such a large chunk of so called ‘organic by neglect’ family farms in the rural area couldn’t be converted to real organic. In the study area, accessibility towards basic infrastructure dividing whole area into peri-urban and rural setting has significant implications for employment opportunities, infrastructural support, agro-chemical availability, market access and dependence on subsistence farming along with variations in farming practices. Spatial variation leading to lack of off-farm employment, services, infrastructure and improved input and subsistence farming makes rural area a vulnerable place to live in. Nevertheless, natural environment with scenic beauty and social harmony should also be reckoned with. The low lying valley hinterlands with good access to road and other infrastructures and access to the market makes this area an ideal place to live in but agro-ecological degradation should be taken into immediate concern. The finding supports that there is a significant effect of road and other infrastructures on socio-economic issues and farming differentiation. Spatial analysis of socio-economic data and farming practices has implications for policy and project development, particularly road and agriculture development projects.

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ASSESSING THE IMPACT OF AMBIENT OZONE ON GROWTH AND YIELD OF CROP AT RAMPUR, CHITWAN

K. Kharel[1] and L. P. Amgain[2]

ABSTRACT

An experiment was conducted at Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal during March-July 2008 to explore the impact of ambient ozone on crop growth and yield. Mungbean cultivar "Pratikshya" was used as a test crop for the study. Mungbean plants were planted in 40 pots and 50% of the plants (i.e. plants in 20 pots) were treated with ethylenediurea (EDU) from 13 DAS to crop maturity at 10 days intervals. The ambient ozone level of the site was measured with passive samplers. The ozone level ranged from 29.3 to 39.1 ppb at the experimentation site during the cropping period. It was found that the ambient ozone at the site caused significant effects on plant growth and yield. The observed ambient ozone was found to reduce the growth parameters like plant height, per plant number of leaves, and number of branches by 10%, 27.74%, and 10.88%, respectively at 70 DAS while it reduced per plant number of seeds (13.17%), seed dry weights (19.67%), test weight (g/1000 seeds), (10.28%), total above-ground biomass (16.60%), harvest index (6.25%), and shelling percentage (5.07%) of controlled over EDU treated plants (ozone protected). The study clearly indicated that ambient ozone contributes to lower plant growth and crop yield.

Key words: Ambient ozone, ethylenediurea (EDU), passive sampler

INTRODUCTION

Ambient ozone is both an air pollutant and a greenhouse gas (Tonneijck and Van Dijk, 1997). Its concentrations have doubled since pre-industrial times, with average annual concentrations ranging from 20 to 45 ppb in the major parts of the world (Booker, 2007). In Asia, its concentration is alarmingly high with severe O3 episodes of 90–200 ppb in some large metropolitan areas of many countries (Emberson, 2007).

Ambient ozone is assumed to be the most important phyto-toxic air pollutant (US EPA, 1996; cited in Elagoz and Manning, 2002) and causes more damage to plants than all other air pollutants combined (USDA, 2000). Effects of elevated O3 concentration include a decrease in plant growth and an alternation in plant metabolism that would ultimately reduce the crop yield (Emberson et al., 2003). Furthermore, O3 sensitive plants frequently exhibit visible foliar injury, and also reduction in nutritional quality in some crops and forages (Booker, 2007). These effects may be due to effect of O3 in physiological processes of plants such as stomatal functioning, photosynthesis, respiration, and translocation of photosynthates (Chappelka and Chevone, 1992; Skarby et al., 1998; Musselman and Massman, 1999; cited in Kainulainen et al., 2000).

Emberson and Büker (2008) reported that current day concentrations of ground level O3 are commonly reducing crop yields by 5-35% of agriculturally important locations across south Asia. Since Nepal is sandwiched between two giant industrial nations, India and China, the ambient ozone concentration could have been contributed to lower crop yield in the country. But, no in-depth studies have been conducted in Nepal yet to assess effect of ambient ozone on crop yield.

[1] M.Sc. Agriculture, Ph. 12542923513, Email: kabboo17@yahoo.com
[2] Assistant Professor, IAAS, Rampur Chitwan, Email: lp_amgain@rediffmail.com

This study was an initiative on impact study of ambient ozone in Nepal. During the study, ambient ozone at the research site was measured and its effects were monitored on mungbean, an important summer crop in Nepal.

MATERIALS AND METHODS

The experiment was carried out at the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan. It is situated at 27°37´N, 84°25´E and about 256masl. The duration of study was from March to July 2008 (while actual cropping duration was April-June). The air temperature and relative humidity of the research site were measured with Tinytag (a data logger). The passive samplers (5 pairs provided by IVL Laboratory, Sweden) were used to measure the ozone concentration integrated over time. Approximately 10 liter volume pots with a 25 cm surface diameter and 30 cm height were used for experimentation. Approximately 8.5 kg of soil-mix (local soil: sand: compost = 1:1:1) was used per pot. The composite sample was analyzed at Soil Management Directorate, Hariharbhavan, Lalitpur, Nepal. The result of the test is presented in Table 1.

Table 1: Soil used in experiment (2008)

Details	Results	Remarks
pH	5.5	Acidic
N (%)	0.13	Medium
P_2O_5 (kg ha^{-1})	67	High
K_2O (kg ha^{-1})	298	High
Organic Matter (%)	2.6	Medium

Approximately 30g locally available fertilizer Samadhan (NPK in the ratio of 19:19:19) and 1g micronutrient MgO were mixed in the soil and applied in each pot for balanced nutrient supply. Each pot was provided with three fiberglass wicks extending to the water reservoirs below them. This method of watering plants was applied to check the rapid downward movements of EDU during irrigation.

On April 7 2008, three seeds of mungbean cultivar “Pratikshya” were sown per pot. At 10 DAS, they were thinned to one plant per pot. Thus, only one plant per pot was exposed to ambient ozone in the field. At 13 DAS, 50% of the plants (i.e. alternate 20 pots) were treated with 100ml of 400ppm freshly prepared EDU solution in distilled water. The EDU application was repeated in every 10 days until the maturity of reproductive parts with an increasing volume of 50ml at every 20 days. Controlled plant was treated with the similar volume of only distilled water.

Weeds were removed from the pots and around the pots as necessary throughout the experimental period. Watering was done through the fiberglass wicks that were projected into the water reservoir (water bucket) and through natural rainfall. As plant protection measures, organic pesticide “Azadaractin” and “Servo” were applied because they were supposed to have neutral interactions with ozone. Harvesting of mungbean was done when pods were turned brown. Three pickings were done within a week period.

Plant heights, per plant number of leaves, and branches of both control and EDU treatments were recorded at 40, 50, 60, and 70 DAS while yield parameter were calculated at crop harvest.

The data recorded on different parameters were analyzed with paired t-test using SPSS software program.

RESULTS AND DISCUSSION

AMBIENT OZONE AND METEOROLOGICAL RECORDINGS

Ambient ozone concentration accumulated over time, maximum and minimum air temperature, and the relative humidity data for the experimental period are presented in Fig.1.

The ambient ozone level was measured at 28 days interval. Highest level of mean ozone concentration (39.1ppb) was observed during April 27 to May 24 and lowest level (17.1ppb) was observed during June 22 to July 19 2008. However, 29.3 to 39.1ppb of ambient ozone level were recorded during crop period (April – June, 2008) This study clearly shows that the periods with high temperature, long sunshine hours, less rainfall, and minimum RH favor the highest level of ozone concentration. This is consistent with the finding of Agrawal et al. (2005) who reported that the high temperature with long light duration favored O3 formation due to long range transport of ozone precursors. Similarly, USDA (2000) observed high concentrations of ozone during calm, sunny, spring and summer days.

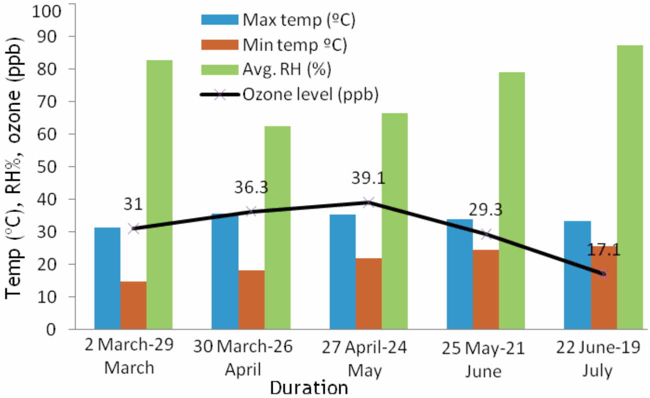

Fig.1: Ambient ozone and meteorological recordings during experimental period (2008)

PLANT GROWTH ATTRIBUTES

Mean plant height, per plant mean number of leaves, and the mean number of branches of mungbean under control (Non EDU), and EDU treatments during different observations are shown in the Table 2.

Table 2: Measurement of growth parameters of mungbean (Mean±S.E.) (2008)

Days after sowing (DAS)	Control	EDU treated	% reduced due to ambient ozone
Plant height			
40	30.80± 1.25	32.50 ± 1.19	5.23
50	36.86± 1.10	41.14 ± 1.22*	10.40
60	39.64 ± 1.16	44.02 ± 1.17*	9.95
70	40.41 ± 1.23	44.90 ± 1.13*	10
No of leaves/plant			
40	29.35± 1.14	31.05 ± 1.11	5.47
50	35.65 ± 1.75	40.35 ± 1.60*	11.64
60	32.20 ± 2.26	39.85 ± 1.94**	21.33
70	28.00± 2.18	38.75 ± 2.47**	27.74
No of branches/plant			
40	4.00 ± 0.27	4.15 ± 0.22	3.61
50	5.95 ± 0.34	6.50 ± 0.32	8.46
60	7.45 ± 0.39	8.35 ± 0.30	10.77
70	8.60 ± 0.31	9.65 ± 0.25*	10.88

Significant differences between control and EDU treatment are indicated as: * = $p<0.05$ and ** = $p< 0.01$

Plant height

No significant difference in plant height was observed during earlier plant growth period. However, significant difference in plant height (i.e. higher plant height) was observed after

50 DAS onwards with EDU treated plant than control ($p<0.05$). At 50 DAS, plant height was reduced by 10.40% in control plants than in EDU treated plants. At 60 DAS and 70 DAS, the plant heights were lesser by 9.95% and 10%, respectively in control than in EDU treatments. At the crop maturity, the reductions in plant height in control compared to EDU were smaller than expected. This fact may be due to the breakage of tips of some plants at later stages of growth. However, almost 10% reduction was noticed even at 60 DAS and 70 DAS. It is clear that EDU played significant role to lessen ozone effect in EDU treated plants while control plants were affected by ambient ozone.

Agrawal *et al.* (2005) also reported similar findings under ambient conditions. They reported 12.3% increase in plant height of EDU-treated mungbean at 80 DAS in the experiment carried under ambient conditions in India. They also reported significant difference in plant height at later stages compared to early stages. Increased response of plants with time on compounding of the ozone effect could be the reason for this as reported by Morgan *et al.* (2003).

Number of leaves per plant

The number of leaves per plant was almost similar in both EDU treated and control plants up to 40 DAS. But, there was significant difference between the number of leaves of control and EDU plants after 50 DAS. Percent reduction in control plants were 5.47 %, 11.64 %, 21.33 % and 27.74 % compared to EDU treated plants at 40, 50, 60 and 70 DAS, respectively. This decreased numbers of leaves per plant in control plants might be due to the effects of ozone whereas the increasing trend in percent reduction might be due to the cumulative action of EDU on plants to build up counter-ozone quality. Similar findings were reported by Tonneijck and Van Dijk, (1997). They reported less number of leaves of Trifolium subterraneum on ozone exposure but higher number of leaves with the application of EDU.

Further, lesser numbers of leaves were noticed per plants at 60 and 70 DAS in both control and EDU treatments; however, severe losses of leaves were observed in control plants. This decreased numbers of leaves in control plant (Non-EDU) may be due to severe senescence during the later stage of plant life as stated by Booker (2007). He reported leaf senescence as one of the most common effects of ambient ozone in plants. Harti et al. (1995) found defoliation of leaves was relatively earlier in non EDU plants than EDU plants of *Phaseolus vulgaris* L.

Number of branches per plant

During 40 to 60 DAS, the mean numbers of branches per plant in EDU treated plants were higher than in control plants though they were not statistically different ($p>0.05$). But, the mean numbers of branches per plant in EDU treated plants was significantly higher at 70 DAs than in control plants ($p<0.05$). It was noticed that ambient ozone reduced the number of branches of control plants by 3.61 %, 8.41 %, 10.77 % and 10.88% at 40, 50, 60, and 70 DAS, respectively. Manning et al. (2004) also reported lower number of branches in apple trees grown at high ozone level.

Root dry weight

Dry roots of each plant of both the control and EDU treatments were weighed at final harvest. The observations are shown in Table 3. The mean root dry weight was observed significantly higher in EDU treated plants compared to control ($p<0.05$). It might be due to effect of EDU on plants as reported by Harti, et al. (1995) in bean (*Phaseolus vulgaris* L.) in open-top field chambers experiment. While, in contrast, Perera and Wijesooriya (2007) reported slightly higher root dry weight in Non-EDU plants of mungbean under ambient conditions. They also added that plants under any stress conditions may increase their root biomass as a mechanism for better survival.

Plant yield attributes

Different yield parameters: per plant number of seeds, seed dry weight, seed test weight, above ground biomass, harvest index (HI) and shelling percent of both control and EDU treated plants were observed at harvest and are presented in Table 4.

Table 3: Mean root dry weight (g) of mungbean plant at final harvest (Mean±S.E.) (2008)

Parameters	Control	EDU treated
Dry root weight	1.22 ± 0.05	1.42 ± 0.04*
CV%	20.68	14.63

Significant difference between treatments is indicated by * ($p < 0.05$)

Seed dry weights per plant and above ground biomass were highly significant in EDU treated plants than control ($p < 0.01$). Also, the number of seeds per plant and shelling percentage were significant ($p < 0.05$) in EDU treatment compared to control. Besides, the harvest index was found at par between treatments. The mean number of seeds per plant, dry weight of seeds per plant and test weight of seeds were reduced by 13.17%, 19.67%, and 10.28%, respectively in control plants over EDU treated ones.

Fumagalli et *al*. (2001) reported 17–39% yield loss in crops such as wheat, bean, watermelon and tomato in ambient conditions. Increment in the number of seeds per plant in EDU treated plants further suggested a protective role of EDU under elevated O3 levels. Wahid et al. (2001) reported that EDU treatment increased 47% and 94% in seed weight per plant in soybean (*Glycine max* L.) at the sub-urban sites and at the rural sites of Punjab, Pakistan. Similarly, test weight of mungbean plant at ambient ozone was found to be increased by 25.3 % in EDU treated plants over control ones (Agrawal et al., 2005). Tiwari et al. (2005) have reported an improvement of seed yield in wheat (*Triticum aestivum* L) by applying EDU under ambient conditions.

Table 4: Measurement of yield parameters of mungbean (Mean±S.E.) (2008)

Yield Parameters	Control	EDU treated	% Reduced due to ambient ozone
No of seeds/plant	173.35 ± 9.25	199.65 ± 6.47*	13.17
Seed dry weight/plant (g)	5.92 ± 0.28	7.37 ± 0.23**	19.67
Test weight of seed (g)	33.15	36.95	10.28
Above ground biomass (g)	18.98 ± 0.58	22.76 ± 0.67**	16.60
Harvest Index (HI)	0.30 ± 0.01	0.32 ± 0.01	6.25
Shelling%	63.81 ± 0.93	67.22 ± 0.64*	5.07

Sig.nificant difference between treatment sis indicated by * ($p < 0.05$) and **($p < 0.01$)

Total above-ground biomass of each plant, harvest index and shelling percent were reduced by 16.60%, 6.25% and 5.07%, respectively in control plants over EDU treated. It might be due to higher ambient ozone level at the site. Krupa et al. (2001) found depressed plant biomass due to high ozone. Harti et al. (1995) also found that the increased O3 concentration significantly decreased shoot biomass of *Phaseolus vulgaris* L. whereas EDU treated plants had higher biomass than control ones. Similarly, Astorino et al. (1995) reported 57 % reduction in the total above-ground biomass on bean (*Phaseolus vulgaris* L.) near-ambient level of ozone. Moreover, he suggested that increment in number of pods and seeds/pod and test weight due to EDU-treatment contributed to higher harvesting index of EDU treated plants as compared to control ones.

CONCLUSION

This study suggests that the ambient ozone at Rampur, Chitwan is high enough to cause significant loss on growth and yield of mungbean. However, different crops may have different responses to ambient ozone. Ozone level measurements at different locations across the country and impact study in different crops may reveal the actual scenarios of ambient ozone level and its impacts in Nepal.

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TOTAL BACTERIAL COUNTS OF RAW MILK IN EASTERN TERAI OF NEPAL

Lekh Raj Dahal MSc[1], Dainik B. Nepali Karki PhD[2] and Ramashish Shah MSc[3]

ABSTRACT

This study was carried out to evaluate the quality of raw milk measured by Total Bacterial Count (TBC). Bulk raw milk for bacteriological study was carried out in Regional Veterinary Laboratory (RVL), Biratnagar. Altogether, 520 milk samples for TBC were examined at farm and plant levels. Results showed a great variability of TBC for the overall study period. The lowest TBC (2.78 x 106) and the highest TBC (13.299 x 106) at two milk collection units revealed nearly fivefold difference. The results of mean TBC at farm (9.03 x 105) was nine fold of international standard (1 x 105), and mean TBC at plant (104.71 x 105) reached 104 folds the international standard. The TBC at farm level were non significant (P>0.05) for overall experimental period where as most of TBC at plant level differed (p<0.01) significantly. TBC at farm level differed significantly (P<0.01) from each record of same date at plant level. The highest number of TBC (16.5 x 106) was observed in the month of September, which was significantly (P <0.01) different from the rest of the months. The results obtained from the study indicated that the current situation is critical and needs real improvement from production point to processing plant.

Key words: Raw milk, Total Bacterial Count (TBC)

INTRODUCTION

Milk is synthesized in specialized cells of the mammary gland and is virtually sterile when secreted into the alveoli of the udder (Tolle, 1980). Beyond this stage of milk production, microbial contamination can generally occur from three main sources (Bramley and McKinnon, 1990); from within the udder, from the exterior of the udder and from the surface of milk handling and storage equipment. All these sources of contamination influence the Total Bacteria Count (TBC) or Standard Plate Count (SPC). Cattle and buffaloes provide direct cash income and are living bank for marginal farmers (Nakao, 2005). To target the export market the quality of the milk is to be standardized and pricing should be based on milk quality. Products should be diversified so that they suit the export market. However, hygienic and quality regulations for production and distribution of milk are more relaxed in Nepal, and are not subject to specific microbiological standards in a legal sense. Gaps and deficiencies in such standards are to be identified and made compatible with codex, a standard setting organization of World Trade Organization (WTO) and South Asia Free Trade Agreement (SAFTA) which have potentially opened markets in the South Asia Region. Nepal will have to compete aggressively on price along with quality. Dairy farming is one of potential agri-business in the eastern Terai. Thirteen percent of total milk production of the country is shared by Eastern Terai, out of which Sunsari and Morang districts occupy about 38.28 % of milk production of Eastern Terai (MOAC, 2007). Hence, the present study was designed to evaluate the quality of raw milk as influenced due to level of management and milk handling procedures on TBC as the bulk milk quality indicator at production point and processing plant and to examine the trend of different milk quality variables for the study period.

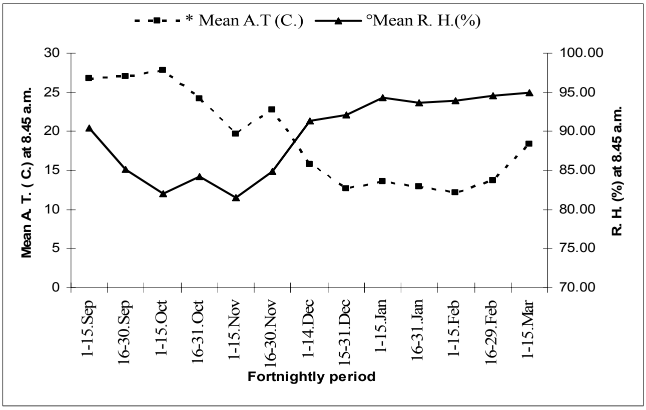
MATERIALS AND METHODS

The site selected for this study was Kamadhenu Dairy Development and Cooperative Ltd (KDDC), Tarahara Sunsari and its command area (milk-shed area of Morang and Sunsari

[1] Senior Veterinary Officer, Ph. 025530667 and 9842031653 (M), Email: lrdahal2003@yahoo.com
[2] Professor, IAAS, Rampur, ph. 9855056176
[3] Lecturer, IAAS, Rampur, Ph. 9845051032 (M), Email: ramashish_shah@yahoo.com

districts). The KDDC was chosen as study site because it represents one of the successful dairy cooperatives run by livestock farmers themselves in Nepal. Furthermore Sunsari and Morang are leading milk producing districts after Ilam in organized milk market of Eastern Nepal (MOAC, 2007). The KDDC, Tarahara is situated around 4 municipalities: Dharan, Itahari, Inaruwa and Biratnagar, heart of eastern Terai of Nepal, which distributes and markets about 6000 liters of milk daily with storage capacity 20,000 liters.

Raw milk samples (25 ml each) were collected aseptically into sterile screwed test tube in the morning at two points - one from bulk milk of each milk collection unit just before pouring into milk plant (hereafter referred as milk at plant level or MPL) and another randomly selected three farmhouses of each milk collection unit (hereafter referred as milk at farm level or MFL). The collected samples were kept in an ice box, and then processed immediately after delivery to the Regional Veterinary Laboratory (RVL), Biratnagar. Ten samples, one from each milk collection unit at plant level and 30 samples from randomly selected three farmhouse of each milk collection unit at farm level were collected. Altogether a total of 520 raw milk samples were collected at fortnightly interval from ten milk collection units of KDDC, Tarahara during mid September 2007 to mid March 2008.



Every milk collecting unit was considered as a block to minimize the variation. Two Factor Randomized Complete Block Design (RCBD) was applied as factor A (dates), and factor B (MPL and MFL). Microorganism counts were expressed in colony forming units (cfu) per ml of milk.

Fig. 1: Trend of fortnightly average dry bulb temperature and relative humidity recorded at 8.45 a.m. at Tarahara, Sunsari over six months study period (* A. T. : Ambient Temperature; R. H. : Relative Humidity .

The milk samples were subjected to TBC in the testing laboratory. TBC was accomplished as per Quinn et al. (1994) who prescribed serial ten-fold dilutions of the milk sample. Hence, TBC were determined by the pour plate method on nutrient agar. Fortnightly meteorological data related to dry bulb temperature and relative humidity is presented in Fig.1 which was obtained from Koshi Basin Office, Dharan, Sunsari in 2008. TBC data obtained from experiments were transformed into decimal logarithm scale to normalize their frequency distributions. Descriptive analysis was performed using MS Excel 2003. Analysis of variance (ANOVA) was performed according to Gomez and Gomez (1984). Means were separated by DMRT using MSTAT-C version 1.3 computer package.

RESULTS AND DISCUSSION

TBC AT DIFFERENT MILK POCKET AREA

Mean TBC per ml of milk of different MCU of KDDC, Tarahara is presented in Table 1. Accordingly, maximum (13.299 x 106) TBC per ml of milk, which was recorded in Bahuni area indicating the most miserable condition of milk handling and management differed significantly (P<0.01) from other milk pocket areas. Minimum (2.78 x 106) TBC per ml of milk which was recorded in Santinagar, Itahari area showing the better condition of milk production was significantly different (P<0.01) from that of Bahuni, Lalpur and Letang area but did not differ significantly (P > 0.05) from rest of MCU. The high variability of TBC from MCU to MCU in the present study was supported by the finding of Srairi et al. (2006).

Heavy contamination was found in milk collected from Bahuni, Lalpur and Letang areas. It might be due to the result of long distance of these MCU to reach to milk plant, which took almost more than 5 hours in transportation. Especially, milk from these three MCU was delivered to plant around 10:00 to 10:30 am and until then there was a rise in an ambient temperature which automatically influenced in milk temperature as well. The increased temperature might have favored bacterial multiplication of milk. Similar observation was made earlier by CUCES (1999) who observed very low increment of bacterial population at 400 F and 5 fold at 500 F, 15 fold at 600 F, 700 fold at 700 F and 3000 fold at 800 F indicating a high positive relationship between temperature rise and multiplication of bacteria.

Table 1: Mean TBC of raw milk of different MCU of KDDC, Tarahara Nepal

MCU	Transformed TBC means	Original TBC means
Upper Santinagar, Itahari-3	6.348bcd	3.587×10^6 bcd
Latijhoda, Sundarpur	6.310d	4.310×10^6d
Banuni	6.529a	13.299×10^6a
West Baklauri	6.277d	4.894×10^6cd
Bamhrapur, Hanspokha	6.306d	3.582×10^6d
Santinagar, Itahari	6.310d	2.780×10^6d
Mrigauliya, Gothgaon, Salakpur And Biratchowk	6.338bcd	5.030×10^6bcd
Kumarkhat, Baklauri	6.314cd	3.516×10^6cd
Lalpur, Singiya	6.420b	6.880×10^6b
Letang	6.403bc	8.990×10^6bc
CV%	2.41	

Means in column followed by different letters are significantly different (P=0.01) by Duncan's Multiple Range Test (DMRT).

TBC AT PLANT AND FARM LEVELS

The mean TBC at MPL and MFL for the study period (September15, 2007 to March 15, 2008) are presented in Table 2.

Table 2: Mean TBC of raw milk at plant level (MPL) and milk at field level (MFL) at KDDC, Tarahara Nepal

Date of sample collection	Transformed TBC means		Original TBC means	
	MFL	MPL	MFL	MPL
September 15, 2007	6.020h	7.406a	1.066×10^6h	32.930×10^6a
September 30, 2007	5.996h	7.351a	1.013×10^6h	31.002×10^6a
October 15, 2007	5.988h	7.162b	0.988×10^6h	16.962×10^6b
October 31, 2007	5.978h	7.072bc	0.961×10^6h	14.020×10^6bc
November 15, 2007	5.951h	6.964cd	0.902×10^6h	10.610×10^6cd
November 30, 2007	5.939h	6.862de	0.875×10^6h	8.205×10^6de
December 14, 2007	5.934h	6.738e	0.867×10^6h	6.105×10^6e
December 31, 2007	5.914h	6.604f	0.831×10^6h	4.302×10^6f
January 15, 2008	5.895h	6.358g	0.795×10^6h	2.495×10^6g
January 31, 2008	5.885h	6.281g	0.784×10^6h	2.000×10^6g
February 15, 2008	5.931h	6.313g	0.863×10^6h	2.116×10^6g
February 29, 2008	5.942h	6.393g	0.888×10^6h	2.612×10^6g
March 15, 2008	5.949h	6.424g	0.901×10^6h	2.762×10^6g

Means in row and column followed by different letter are significantly different (P=0.01) by DMRT.

COMPARISON OF TBC WITH INTERNATIONAL STANDARD

The results of mean TBC at MFL (9.03 x 105) was nine times greater than that of international standard (EU standard) (1 x 105) whereas mean TBC at MPL (104.71 x 105) reached 104 fold the international standard due to conducive ambient temperature and relative humidity for the growth of bacteria (Fig.1) accompanied by lacking of milk refrigeration in the situation of long distance milk transportation. Srairi et al. (2006) also reported similar problems concerning hygienic quality of raw milk received by MCU in Morocco. Similarly, Aumaitre (1999) observed similar results due to lapses in milk sanitation. Litwińczuk et al. (1999) and Przysucha et al. (2003) documented difficulties to obtain high quality milk during the summer season. All of them reported that higher air temperatures favour the increase of bacteria number, especially on the surfaces of no good enough cleaned up milking equipment which were the potential source of infection. To date, TBC is not accounted as standard parameter for enhancement of raw milk quality in Nepal. Although TBC (1 x 105) is considered as international standard adopted by EU, Brazilian National Program of Milk Quality adopted 1.0 x 106 cfu / ml of mesophilic aerobic count as national standard, however, ISI has laid down SPC standard (< 2 x 105) for very good quality milk in India. It is too late to standardize different milk quality parameters in Nepal to cope with provision of WTO and to provide healthy milk and milk products to consumers.

TREND OF FORTNIGHTLY RECORDINGS OF TBC

Trend of fortnightly recordings of overall mean TBC of MFL and MPL, and mean TBC at MFL and MPL per ml milk have been depicted in Fig.2. Overall mean TBC and mean TBC at MPL were considerably higher during September and October than the rest of months. Lower microclimatic temperature during winter also reduced bacterial count (<10 x 106). However, mean TBC at MFL was considerably very low (≤ 1.00 x 106) which remained almost unchanged over study period. The present observation of reduced number of TBC, as winter advanced, was in agreement with earlier finding of Srairi et al. (2008) who also observed the highest Log TBC of raw milk during the hottest months of July followed by August to November and the lowest Log TBC during the coolest or driest month of December, January.

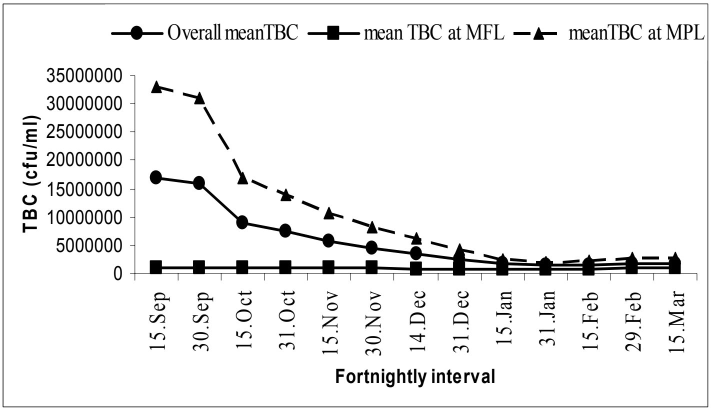


Fig. 2: Fortnightly recordings of mean TBC of MFL and MPL and mean TBC at MFL and MPL per ml milk at KDDC, Tarahara Nepal (15 Sept. 2007 to 15 Mar. 2008)

A higher number of TBC was observed in the month of September as compared to October which might be due to high mean ambient temperature recorded for the same month (Fig.1). The trend of bacterial load showed a positive relation with prevailing ambient temperature. Data obtained from pervious study also indicated higher microbial counts during summer (Tirard-Collet et al., 1991). A similar observation was recorded by Zweifel et al. (2006) in different agro-climatic region in goat milk.

CONCLUSION

The results obtained during this work on the hygienic quality of raw milk in Nepal indicated that the current situation is critical and needs real improvement. In effect, a great majority of milk samples had very high level of bacteria. Lacking refrigeration facilities of milk during transportation from production to processing sites contributed higher microbial load of raw milk. Microbial counts as quality indicator of raw milk and the possible impact of specific influence factors are of central importance, and such specific influencing factors are therefore of great concern in hygienic milk production. The following suggestions are made in order to avail quality milk and milk products to the consumers.

1. Government should include legal enforcement on TBC of marketed milk considering Nepalese situation.
2. NDDB should bring all dairy stakeholders together to set milk pricing policy in order to stimulate the awareness among farmers and processors for quality milk production.
3. Milk refrigeration system during transportation as well as in the milk collection units especially to those areas which are located far from the plant should be developed immediately.

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CLIMETO-CYLIC IMMIGRATIONS WITH DECLINING POPULATION OF WILD HONEYBEE, APIS DORSATA F. IN CHITWAN VALLEY, NEPAL

Suroj Pokhrel, PhD[1]

ABSTRACT

A general survey was conducted to investigate the phenomena of seasonal immigration, aggregation and staying of Apis dorsata Fab. colonies in Chitwan valley, Nepal in 2003/04. The primary immigration of small colonies occurred during November-December in Southern areas and secondary type mainly from site shifting of the large colonies towards north of Chitwan valley in January-February and smaller colonies through swarming in March-April respectively. Maximum colonies aggregated in March with maximum staying of eight months. Colonies aggregation declined by 54%, 50% and 100% in May, June and July and the period of colony staying declined by 25% as compared to previous years. The causes of population decline were: bad weather, predators and parasites, honey hunting, increasing pesticide use, declining bee pasture and inter species competition with exotic A. mellifera L. Policy declaration with suitable programs for the conservation of native wild honeybee, A. dorsata in its indigenous habitat for the maintenance of biodiversity and raising the crop productivity is necessary.

Key words: Aggregation, bee pasture, biodiversity, colony staying, honey hunting, immigration, nesting site, swarming.

INTRODUCTION

Honeybee diversity in Hindu Kush Himalayan (HKH) region consists of Apis cerana F., *A. dorsata* F., *A. florea* F. and *A. laboriosa* Smith and exotic *A. mellifera* L. Among these honeybees *A. dorsata* is a wild, open nesting and single comb building honeybee and is a natural pollinator of several cultivated and wild plants in Asia (Atwal, 1970; Maun and Gurdip, 1983; Singh, 2000). They are distributed throughout the foothills, Terai and inner Terai of Nepal. Their nesting sites are tall trees, buildings, and water towers with available food resources (Lindauer, 1956: Morse and Benton, 1967; Reddy, 1980, Hadorn, 1984; Pokhrel, 2005). However, the biology, aggregation, migration and immigration of this species are poorly understood (Roepke, 1930; Lindauer, 1956; Morse and Benton, 1967; Koeniger and Koeniger, 1980; Seeley et al,. 1982; Hadorn, 1984; Sihag, 1998;). The members of this species are furious and attack in mass for defense (Maschwitz, 1963; Frish, 1967; Morse et al., 1967; Koeniger et al., 1979). They are good honey collectors (Thakar and Tonapi, 1961; Singh, 1980), and therefore, important source of honey in Nepal (Shrestha, 2001). The role of these bees as crop pollinators to augment national income through increased bio-diversity and crop production has been forgotten. In addition, honey hunting, destruction of the nesting sites and the natural pasture (forest), increasing trend of pesticide use for crop protection, reduction of cultivated bee flora and the rapid multiplication of *A. mellifera* colonies in its natural habitat in Chitwan valley Nepal, in nineties, pushed this species on the verge of extinction (Shrestha, 2001; Pokhrel, 2005; Pokhrel, 2006; Pokhrel, 2008; Pokhrel, 2009). Thus, study on the natural biology and cause of decline of *A. dorsata* population in its natural habitat in Chitwan valley was necessary. The objective of the study was to investigate the phenomena of seasonal immigration, aggregation and staying of *A. dorsata* colonies in Chitwan valley, Nepal.

[1] Program Director, Crop Development Directorate, Department of Agriculture, Nepal, surojpokhrel@yahoo.com

MATERIALS AND METHODS

The study was carried out in Chitwan district (inner Terai) in central Nepal. Sites selected for the study were the man-made structures and Bombax trees, which had the previous history of having this bee colonies nesting onto them in aggregate of 3-30 colonies on a single structure/tree at Sukranagar, Mangalpur, Yagapuri, Narayanghat, Aaptari and Bharatpur. All the sites were at 350 metres above sea level. Study was carried out throughout the year, starting from May 2003 to July 2004.

Survey of the nesting sites was carried out at monthly interval to find out the seasonal immigration of *A. dorsata* colonies in Chitwan. Observations were recorded every month on the dates of immigration and number of colonies nesting at particular sites (Sukranagar, Mangalpur, Yagapuri, Narayanghat, Aaptari and Bharatpur) and absconding. Weather data (temperature, humidity and rainfall) were collected from National Maize Research Program, Rampur.

EXCEL software was used to tabulate collected data, to prepare necessary tables, graphs and figures and to calculate means, variance and standard errors.

RESULTS

IMMIGRATION SEASON

November was the beginning month of immigration of *A. dorsata* colonies in Chitwan. The first immigration site noticed was Sukranagar (near by Chitwan National Park) followed by Yagyapuri (Horticulture Farm). Out of five sites observed in Chitwan, the immigration was continued during winter, spring and ended by early summer. In November, there were all together 12 colonies, 9 in Sukranagar and 3 in Yagyapuri. The number increased by 66.7% in December, which decreased in the winter by 60.0% and increased again in spring by 225.0%. Of the total colonies immigrated in Sukranagar, 92.8% occurred in November-December (N=26) and the rest in March-April (N=2). Yangapuri was only a site of continuously immigrating colonies for five months from November to March. Immigration of the colonies in Mangalpur occurred only in January and in Bharatpur (Narayani Safari and Hotel Island) in February-March (Fig.1).

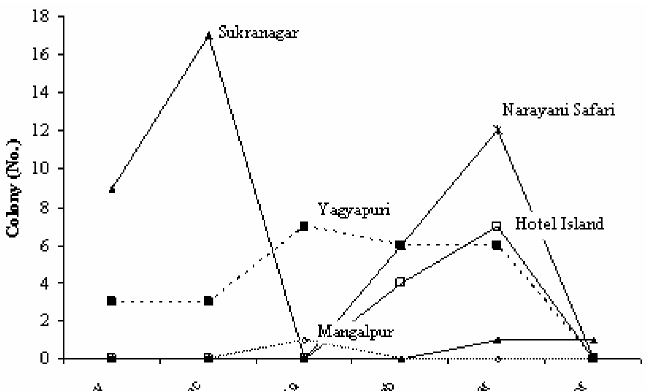

Fig. 1: Immigration of *A. dorsata* colonies in different locations, Chitwan, 2003/04

The immigration was mainly of two types: primary and secondary immigration.

The colonies from a long distance flight arrived to the southern area of the Chitwan, near the Chitwan National Park where the early mustard, Brassica spp. and buckwheat, Fagopyrum esculentum Moench bloomed earlier in November-December. Of the total colonies (N=83), 38.6% (N=32) were the primary immigrant colonies. Over 80.0% of the primary observed immigrant (early in-coming) colonies from long distance nested at a private building at Bishalchock, Sukranagar and the rest nested on the water tower, Yagyapuri (Fig.1).

Secondary immigration was of two types: site shifting and swarming.

Out of the total colonies (N=32) immigrated during November-December in Chitwan, 52.0% (N=17) shifted their nesting sites in January-February. In a total of five locations, incoming colonies (N=83), the secondary immigrants through temporary site shifting were 44.6% (N=37).

Secondly, about one-forth of the colonies immigrated in November-December produced 4-7 queen cells per colony and swarmed in late February. Nearly 17% (N=14) colonies immigrated from swarming in February-March (Fig.1). Both the secondary type of immigrants spread to water tower at Yagyapuri, Bombax tree at Hotel Narayani Safari and Hotel Island at Bharatpur, and private building at Mangalpur.

NESTING SITE

Colonies of *A. dorsata* preferred non-disturbed previous nesting sites. They denied using white washed building at Narayanghat and the standing dead Bombax tree at Aaptari. The private building at Bishalchok, Sukranagar was most preferred due to the least disturbance and being near by the Chitwan National Park where mustard, Brassica spp. and buckwheat, F. esculentum bloomed earlier in November. They nested on tall water towers (Fig.2 and 3), Bombax trees and taller buildings at different locations. The private building at Bishalchok, Sukranagar was most preferred due to the least disturbance and being near by the Chitwan National Park where mustard, Brassica spp. and buckwheat, F. esculentum bloomed earlier in November. They nested on water towers, Bombax trees and taller buildings at different locations.

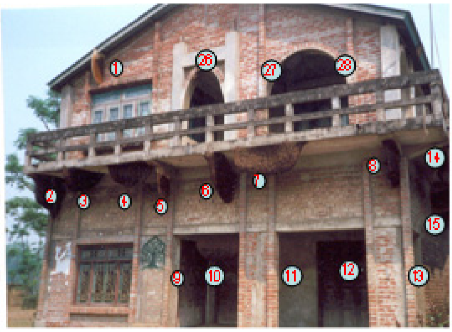

Fig. 2: Colonies nesting on a non-disturbed building at Sukranagar, Chitwan, 2003/04

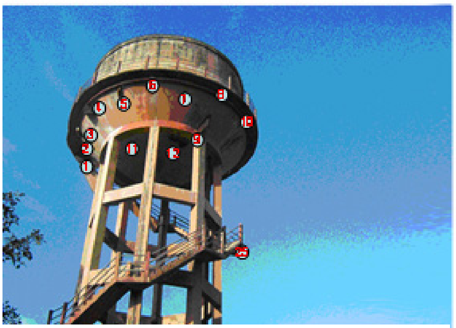

Fig. 3: Colonies nesting on a non-disturbed water tower at Yagyapuri, Chitwan, 2003/04

DECLINING RATE OF COLONY IMMIGRATION AND AGGREGATION

The highest number of *A. dorsata* colonies (N=67) aggregated during March at all locations except at Sukranagar where the nesting colonies were the highest (N=26) in December. The colony number severely decreased after March ending in October in 2003 and in July in 2004. The bee colonies at Sukranagar, Yagyapuri and Hotel Island left in July; however, in Narayani Safari they left two months earlier i.e. in May 2004. In disturbed locations (Aaptari and Pradhan Stationary) in Narayanghat, the maximum number of the colonies was observed in March (N=7) in 2003 and all the colonies left by September, and did not return in 2004 (Fig.4).

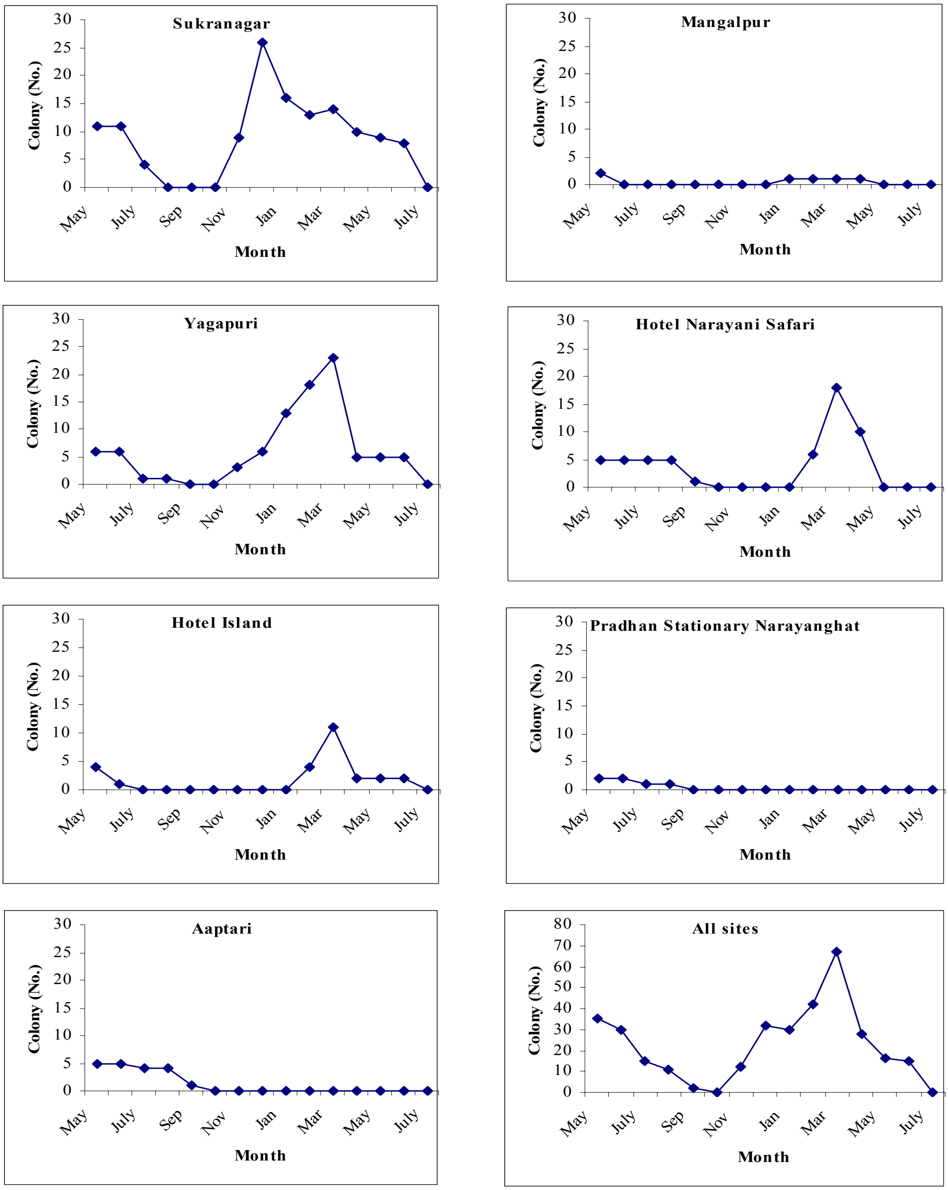

Fig. 4: Aggregation of *A. dorsata* colonies at different sites, Chitwan, 2003/04

DECLINING RATE OF COLONY AGGREGATION AND PERIOD OF STAYING

The number of *A. dorsata* colonies aggregated at different locations of Chitwan declined by 54.0%, 50.0% and 100% in May, June and July in 2004 compared to 2003. All the colonies left three month earlier (July) in 2004 as compared to 2003 (Fig.5). It was declined at Sukranagar by 18.2%, 27.3%, and 100% in May, June and July, respectively, in 2004. Bee colonies leaving their occupied sites differed 1-5 months at different locations, i.e. one month earlier at Mangalpur, two months at Yagyapuri and five months at Narayani Safari. The reason behind this might be environmental and climatic, and increased farming of the exotic honeybee, *A. mellifera* in Chitwan valley.

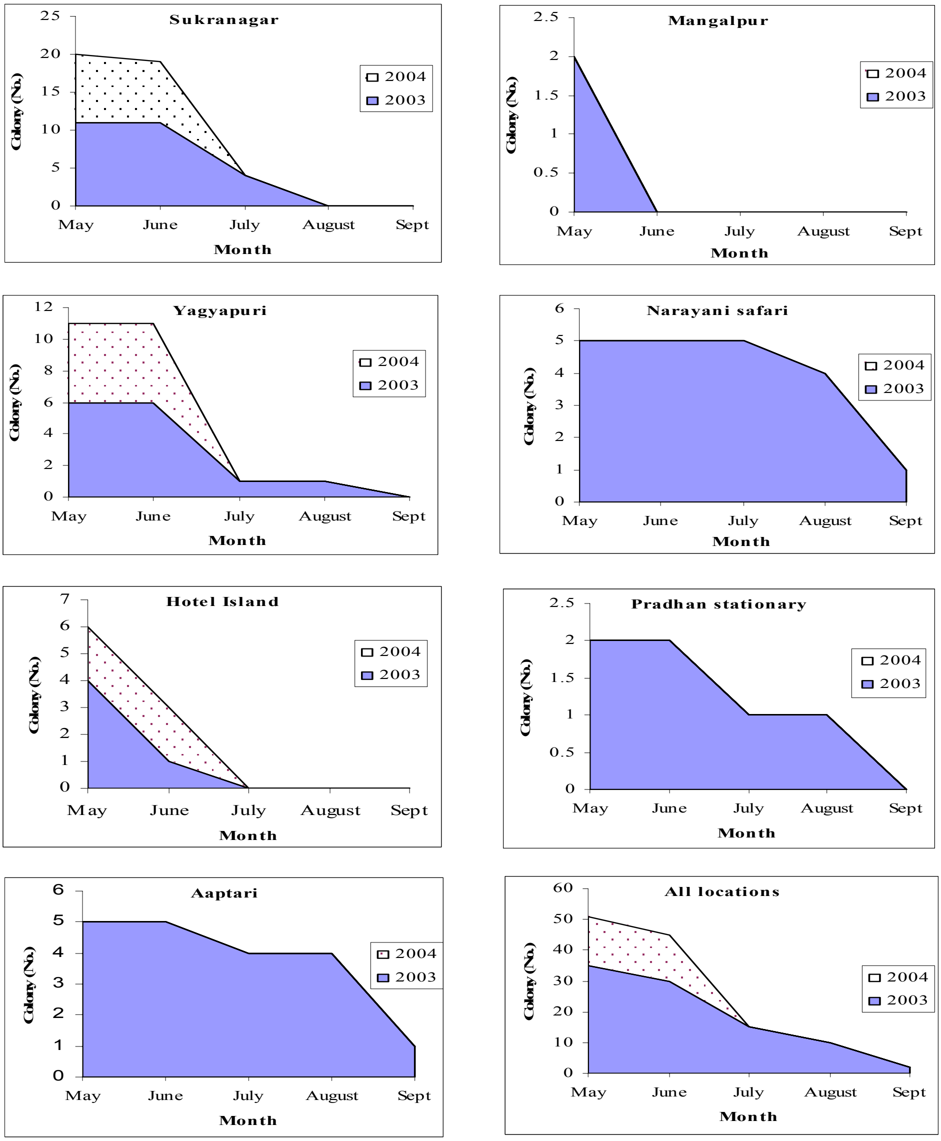

Fig. 5: *Apis dorsata* colonies staying during May-September in Chitwan, 2003/04

CORRELATION BETWEEN THE PARAMETERS

All parameters except initial colony size (r=-0.211) with colony immigration were positively correlated with each other (Table 1). Aggregation of *A. dorsata* colonies positively correlated with immigration (r=0.473), initial colony size (r=0.307), and colony migration (r=0.263). Similarly, colony migration was positively correlated with colony immigration (r=0.258), colony aggregation (r=0.263), colony growth rate (r=0.070), and initial colony size (r=0.141).

Table 1: Correlation between the parameters of A.dorsata colony migration in Chitwan, 2005.

Parameter	Colony immigration (No.)	Colony aggregation (No.)	Initial colony size (cm2)	Migration (No.)
Colony immigration	1.000	0.473	-0.211	0.258
Colony aggregation	0.473	1.000	0.307	0.263
Initial colony size	-0.211	0.307	1.000	0.141
Migration	0.258	0.412	0.141	1.000

DISCUSSION

Three cyclic immigrations of the *A. dorsata* colonies occurred in November-December, January-February, and February-March in Chitwan, Nepal. The primary immigration of 38.6% very small colonies (591.8 cm2 and 549.8 cm2) occurred in November-December from the long distance flight. In January-February, the secondary immigration (44.6%, N=37) of the larger colonies (2302.8 cm2 and 1188.6 cm2) was through temporary site shifting and nearly 17.0% (N=14) much smaller (225-713 cm2) colonies spread from swarming in March-April. Shrestha (2001) reported that most of them immigrated in Chitwan in November. The returning time of this bee in the upland of Srilanka and in Banglore, India was little earlier i.e. at the starting of dry period (October-December) (Koeniger and Koeniger, 1980) but it was late at the end of February in Mae Tung Ting and Mae Hong Son, Thailand. Hadorn (1984) observed only two cyclic immigrations of 2-3 months in Sumatra and Thapa (1998) observed two peaks of reoccupation and abandonment of nest sites in Chiang Mai, Thailand, first in November and second in January-February. The first two immigrations were similar with as explained by Thapa (1998) and Shrestha (2001). In Chitwan, additional third immigration was observed in March-April, which was from queen rearing during favorable season in February and swarming during March-April, when maximum number of bee flora were available (N=96).

The honeybee colonies nested on tall water towers, Bombax trees, and taller buildings at different locations in Chitwan. The first site of immigration was in south, near Chitwan National Park and around a horticulture farm in South-west of Chitwan. They preferred non-disturbed previous nesting sites near fields having early crop of mustard, *Brassica spp*. and buckwheat, Fagopyrum esculentum Moench blooming in November-December. They denied using white washed buildings and standing dead Bombax trees. Lindauer (1956), Morse and Benton (1967), Reddy (1980) and Seeley et al. (1982) also found the similar, non disturbed nesting sites of *A. dorsata* throughout South and South-east Asia. Mardan (1989) and Crane (1990) explained the nest site chosen by *A. dorsata* swarms for nesting was usually not directly exposed to wind currents and partially sheltered. Swarms closer to the old nest sites got first opportunity to occupy the protective nest sites and also exploited natural and cultivated flora for their survival, growth and development.

Colony aggregation was up to 28 at a private building near Chitwan National Park, 25 on a water tower at Horticulture Farm, and 18 on a Bombax tree at Hotel Narayani Safari. Aggregation of these colonies started from November, reached the highest in March (N=67). Aggregation of 69 colonies on a single tree and 72 on a water tower was reported in Thailand and Nepal, respectively (Wongsiri et al., 1996; Thapa, 1998). Shrestha (2001) reported 31 colonies nesting (as close as 46 cm apart) on a water tower at the Institute of Agriculture and Animal Science at Rampur in 2000. The aggregation of these colonies on a tree/structure has been reported from 30 to 150 (Roepke 1930; Lindauer 1956; Morse and

Benton 1967; Koeniger and Koeniger 1980; Seeley et al., 1982; Hadorn 1984). Such aggregations of colonies was for the availability of the drones for mating (Singh, 1962; Koeniger and Koeniger, 1980; Seeley et al., 1982; Mardan, 1989; Koeniger et al., 1994; Oldroyd et al., 1996; Wongsiri et al., 1996;), for reducing predation risk and accelerating out-breeding (Moritz, 1985). Presumably, aggregation of numerous colonies might be for enhancing mutual defense (Brock and Riffenburg, ; 1960 Shrestha, 2001).

The trend of *A. dorsata* colony immigrating and aggregating in Chitwan was declined by 54%, 50% and 100% in May, June, and July 2004 respectively compared to 2003. The reason behind can be environmental, agricultural and the biological. Rapid multiplication of exotic honeybee, *A. mellifera* L. reduction on the area of bee crops, i.e. mustard, deforestation, pesticide poisoning and predation of the colonies might be the causes. Pokhrel 2005, 2006, 2008 and 2009) agreed on these causes of *A. dorsata* population decline. Shrestha (2001) and Pokhrel (2006, 2008 and 2009) recommended conservation and protection from factors or activities bringing about their devastation or pushing them towards the course of extinction from their habitat. Hadorn (1984) and Schmidt et al. (1985) also explained extensive predation of *A. dorsata*, however, the impact on the species was smaller than the destruction of the primary forests with its tall trees in its habitat.

Seasonal immigration of *A. dorsata* colonies coincided with lower rainfall, availability of bee flora and low pest prevalence in Chitwan. Thus, it was mainly due to climato-cyclics and food availability and vice versa for their absconding/long distance migration. Thapa (1998) in Thailand also found positive correlation of *A. dorsata* migration with predators, parasites, temperature, rainfall, wind speed and physical disturbances and negative correlation to the relative humidity. Wongsiri et al. (1996) also found seasonal and cyclic migration of *A. dorsata* colonies in Thailand to exploit new resources. Oldroyd et al. (1996) described the reason of seasonal and cyclic migration and it was for to increase colony fitness by improved food availability, enhanced out-breeding and reduced brood-parasite pressures. Terai of Chitwan valley enriched with bee flora only in winter and spring, where food and nesting sites also are available. Such sites are feasible for *A. dorsata* migration as reported by Hadorn (1984).

CONCLUSION AND RECOMMENDATION

Earlier immigration of the primary immigrants' colonies in Sukranagar and Yangapuri was mainly on the non-disturbed nesting sites and earlier availability of the food sources. Secondary immigration in all the sites was from temporary site shifting and through swarming. The trend of colonies immigration and the period of colony staying declined year after year due to climate change, bad weather, increasing pesticide use for crop production, honey hunting, declining pasture both in forest and agro-ecosystem and inter species competition with exotic honeybee, *A. mellifera* L. in Chitwan. Conservation of *A. dorsata* in its traditional habitat for the maintenance of biodiversity and raising the crop productivity, for which promotion of bee pasture both in forest and agro ecosystem, prevention of pesticide poisoning, reduction of house bee colonies and prevention of honey hunting is necessary.

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IMPACT OF CLIMATE CHANGE ON PRODUCTION AND PRODUCTIVITY: A CASE STUDY OF MAIZE RESEARCH AND DEVELOPMENT IN NEPAL

Janak Lal Nayava, PhD[1] and Dil Bahadur Gurung, PhD[2]

ABSTRACT

The relation between climate and maize production in Nepal was studied for the period 1970/71-2007/08. Due to the topographical differences within north-south span of the country, Nepal has wide variety of climatic condition. About 70 to 90% of the rainfall occurs during summer monsoon (June to September) and the rest of the months are almost dry. Maize is cultivated from March to May depending on the rainfall distribution. Due to the availability of improved seeds, the maize yield has been steadily increasing after 1987/1988. The national area and yield of maize is estimated to be 870,166ha and 2159kg/ha respectively in 2007/08. The present rate of annual increase of temperature is 0.04^{0}C in Nepal. Trends of temperature rise are not uniform throughout Nepal. An increase of annual temperature at Rampur during 1968-2008 was only 0.039^{0}C. However, at Rampur during the maize growing seasons, March/April – May, the trend of annual maximum temperature had not been changed, but during the month of June and July, the trend of increase of maximum temperature was 0.03^{0}C to 0.04^{0}C /year

Key words: Climate-change, global-warming, hill, mountain, Nepal, Tarai

INTRODUCTION

Ecologically, the country is divided into three regions running east to west: Mountain, Hills and Tarai (Plain). Based on the area, these regions constitute 35, 42 and 23 percent of the total land area, which is 147,181 sq. km. Administratively the country is divided into 5 development regions and 75 districts. The area of development regions are shown in Fig.1.

Economic growth of the country has not improved over time to cope up with the population growth, which is 2.3 percent per annum. Around 68 percent of Nepal's population depends upon agriculture and contribution of this sector to the GDP is about 40 percent. Though priority is given to agriculture sector, the crop production in the country is not sufficient to meet the demand of the peoples.

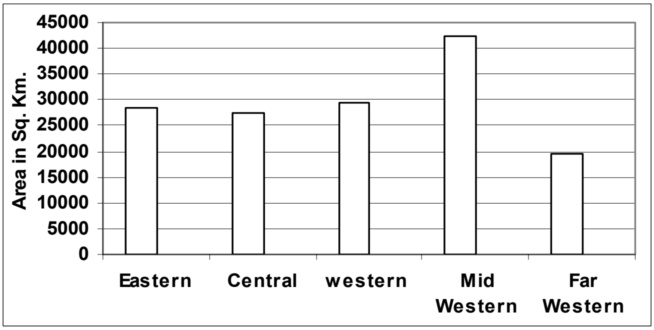

Fig.1: Regional area of Nepal

According to the Population Census 2001, the number of agricultural holdings in the country is 3.2 million and total cultivated area is 23.21 million hectares. Starting from 1995, Nepal is implementing the twenty year long Agricultural Perspective Plan (APP) to overcome the

[1] Freelancer Consultant in Agro-meteorology, Email: drjanaklal@yahooo.com
[2] National Maize Research Project, Rampur, Email: nmrp@techminds.com.np

problems of food insecurity and poverty. The population distribution along with the administrative region is shown in Fig.2.

In Nepal maize is grown in the sub tropical to cool temperate climates. For higher yields, crop water requirement is 500-600mm depending upon the climate and duration of the crop, there should be adequate water during the crop establishment period. Water deficit during the grain filling period results in reduced grain weight. However, during the maturity and harvesting period, rainfall has negative impact on maintaining grain quality.

Knowledge of genetic characteristics and particularly growth and development pattern of maize varieties is essential for meeting the combination of various climatic requirements for growth development and yield formation. It is known that the upper limit of crop production is set by the climatic condition specially temperature regimes and the genetic potential of the variety grown. The extent to which this limit can be reached will always depend on how finely the engineering aspects of water supply are in tune with the biological needs for water in crop production (FAO, 1979). The area under maize cultivation in different regions of Nepal is shown in Fig.3.

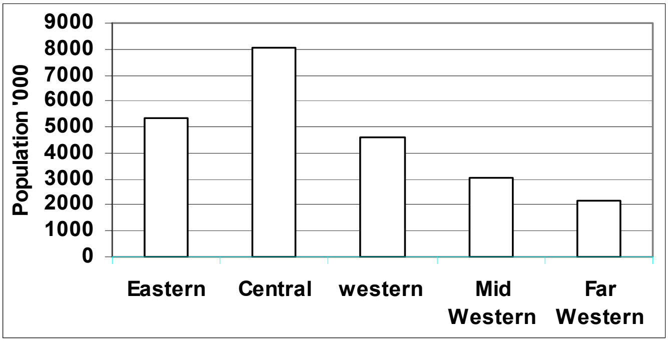

Fig.2: Population distribution in administrative region

DATA

This study is based on data of thirty six years (1970/71 – 2007/08). Climate data were provided by the Department of Hydrology and Meteorology (DHM, 1999a, 2001, 2002, 2005, 2007 and 2009). Source of the maize data is the then Department of Food and Agricultural Marketing Services (DFAMS, 1977), National Planning Commission (NPCS, 1994), Central Bureau of Statistics (CBS, 1999, 2003, 2006) and Ministry of Agriculture and Cooperatives (MoAC, 2002, 2004, 2005, 2006, 2007 and 2008).

Taking into consideration the growing season of summer maize, this study attempts to analyze relationship between rainfall and maize production for whole of Nepal and three ecological belts with a case study at the National Maize Research program in Rampur, which lies in inner Tarai of central Nepal.

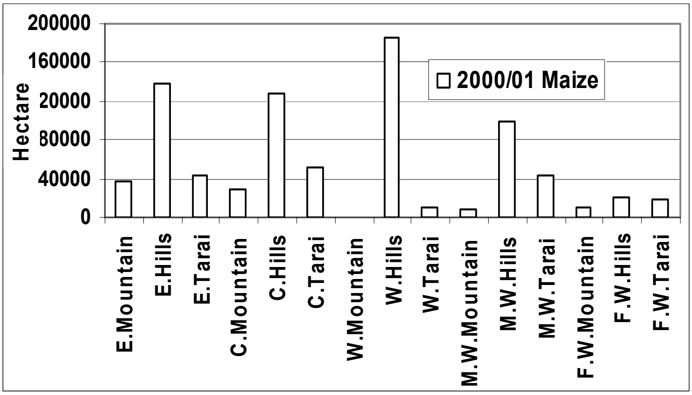

Fig. 3: Maize cultivation in the different regions in Nepal

ANALYSIS

NATIONAL LEVEL

Maize is the second most important cereal crop in Nepal and is also staple food for Hills people. Area under this crop is approximately 870,166ha with an average productivity of 2159 kg/ha in 2007/08. About 70% maize area is in the Hills. Maize occupies 34% of total cultivated cereal crops and contributes 30% as a total edible food in Nepal. Maize is generally grown under rain-fed condition in Nepal. Maize is an important crop for making edible oil and is also significant source of bio-fuel production in the world. Maize is very sensitive to frost. The favorable condition of growing maize is light to medium textured, deep well drained soils free from water-logging. The cool temperature delays maturity in the crop. Cold stress occurs when temperature is below 10^0C and development of plant growth ceases. Similarly, heat stress occurs when temperature is higher than 35^0C.

While observing the maize area in Nepal during 1970/71 to 2007/08, the area was about 445,750 ha during 1970/71 and the area has increased to 870,166 ha in 2007/08. There is clear indication that the area under maize cultivation has increased nearly two folds in 2007 during the study period. The maize production was 833,318 MT in 1970/71 and now the production is 1,878,648 MT in 2007/08. The maize production during the study period of 1970/71-2007/08 has more than doubled and that the increase in production was due to increase in area.

National Agriculture Research Council mentioned that performance in maize production in Nepal has not increased much even though use of improved seeds has increased substantially since 1972. Although attempts on variety development were initiated since middle of sixties, the systematic development work began only after the National Maize Development Program established in 1972 at Rampur.

The seeds of new varieties have increased since then and now area under improved maize is 86% (MOAC, 2008). There are altogether 23 varieties developed for different production environments in Nepal (NARC, 1997, 2005). Maize seeds are planted with 25 cm between plant to plant distance and 75 cm apart between rows to row. The ridges should be made very nicely and maintained to avoid water logging. In general, the first weeding is performed when the plants are 5-8 leaf stage and feeling up is done at the knee high stage.

The national maize area and production from 1970/71 to 2007/08 are shown in Fig.4. Initially during the first and half decade, the production had been decreasing and only after 1986, the production had been steadily increasing trends. In the later part, the yield increased to more than 2 ton per hectare showing progress in maize yields, which is shown in Fig.4. It seemed that the increase in yield was mainly due to adoption of high yielding varieties.

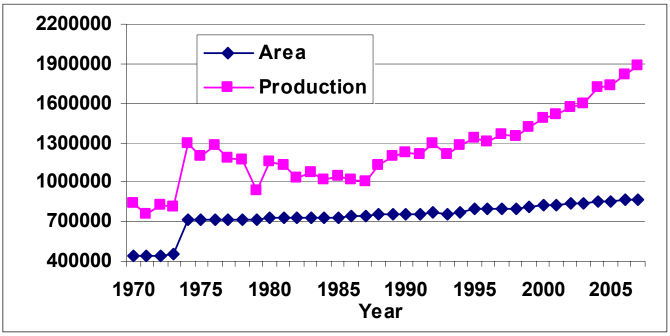

Fig. 4 : National Maize area and Production

ECOLOGICAL BELTS

The Maize area and production in three ecological belts are as follows:

Mountain

In course of studying maize cultivation in the three ecological belts, the Mountain region showed least increment among the three belts The production of maize in the Mountain region increased from 77,800 MT to 183,253 MT during the last 36 years from 1970/71 to 2007/08., But the yield has remained almost constant during the last 27 years and only after 2000 the yield seemed to increase in mountain as shown in Fig.5. General maize plantation starts from March to April and it is totally dependent upon the rainfall. The average annual temperature during the growing season in Mountain was from 18^{0}C to 21^{0}C. In fact, area under maize in mountain was 9.6% of the total maize area and contributed 10.3% of the total maize production in the country. In mountain regions, maize matured in around 180 days.

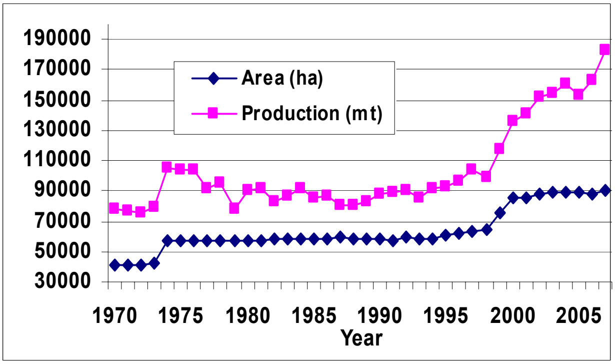

Fig.5: The maize area and production in Mountain

Hills

The maize growing season in the Hills Region is from March/April to July/August. Maize is planted in rain-fed condition in the Hills and depends upon the rainfall distribution. The land preparation starts with rainfall. Maize is generally planted from mid February to the end of April. Maize area is more in the Western Hills compared to the other Hills in Nepal as shown in Fig.6. The maturity period of maize in the hills ranged from 140 to 150 days.

Mean annual temperature during the growing period in the Hills ranged from 21^{0}C to 27^{0}C. Hills regions showed nearly three fold increases in area during the period from 1970/71 to 2007/08. The gap in area and production showed a progressive change after 1988 in the Hills (Fig.6). The production of maize in the Hills increased from 524,700 MT to 1312,254 MT during the study period. In fact Hills region has about 70.4% of the total maize area and contributes 69.7% of the total maize production in the country.

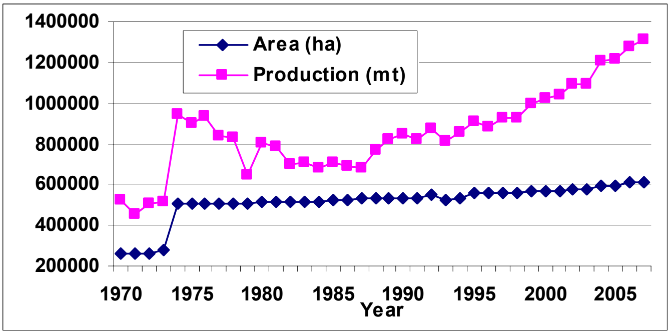

Fig. 6: The maize area and production in Hills

Tarai

Maize is grown during April- July in Tarai. During this period, about 500 to 800mm rainfall occur in the Tarai. Annual mean temperature during the growing period of maize in Tarai is

21^{0}C to 33^{0}C. In fact Tarai region has only 9.1% of the total maize area and contributes 20.4% of the total maize production in the country.

During the last 36 years period from 1970/71 to 2007/08 (Fig.7), the production of maize in the Tarai region increased from 230,700 MT to 383,141 MT. It is interesting to note that the maize yield in Tarai was initially low. In Tarai, area under maize increased by 60% and its yield increased only 71%.

Maize is planted in all three seasons (summer, winter and spring) in the Tarai Region. The planting of summer maize starts from April to May and harvests on August to September. The growing season of winter maize covers from November/ December to March/ April. Similarly, the growing season of spring maize is in March/April and harvests on June to early July. For the summer and winter crops, farmers prefer to grow long duration varieties, where as for the spring maize short duration varieties are preferred. Winter and spring maize is planted, wherever the irrigation facilities are available.

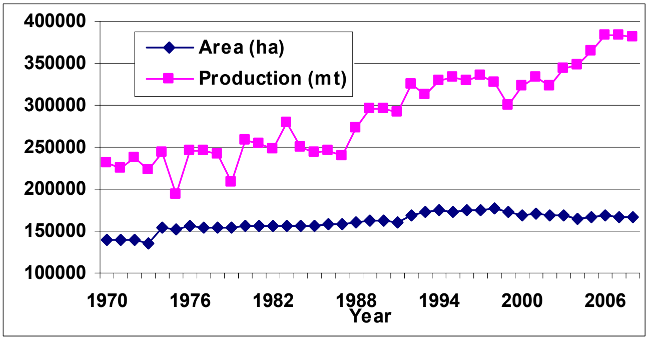

Fig. 7: The maize area and production in Tarai

After the introduction of high yielding varieties, the yield increased in Tarai comparatively more than those of the Hills and Mountain. The yield at three ecological belts are presented in Fig.8, which shows that the yield is higher in the Tarai than in the Hills and the Mountain region.

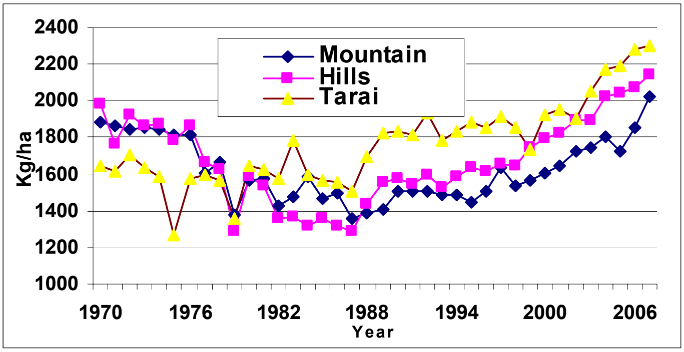

Fig. 8: The maize yield at three ecological belts

A CASE STUDY: NATIONAL MAIZE RESEARCH CENTRE, RAMPUR

The simplified mathematical model known as growth indices developed by Fitzpatrick and Nix (1970) was calibrated in the Nepalese environment by Nayava(1981) and is presented with data from the meteorological station, Rampur, 256m, a district in Central Nepal (Fig.9a and Fig.9b).

The growth Indices (G.I.) considers light (LI), thermal (TI) and moisture regimes (MI) into a linear function with a scale ranging from zero to unity. In this analysis, growth indices (G.I.) has been defined as most favorable G.I. (higher than 0.8), fairly favorable G.I. (0.4 to 0.8) and least favorable G.I. (less than 0.4) are noted. The most favorable climatic condition for cultivation where all environmental indices such as light, thermal and moisture are non-limiting factor for growth, in other words, the index should be higher than 0.8. As a matter of fact, the energy and moisture balance are very necessary for crop under study. The Fig.9a indicate that only one tropical species (TS) can be grown under optimum condition during the week 23 to 42 (June 4 - 10 to October 16 - 22) as rain-fed condition in summer season. Fig.10b show that the three crops (two tropical species during the week 12 to 42 (March 19 - 25 to October 16 – October 22) and one warm temperate species (WTS) as wheat during the week 43 to 13 (October 23 - October 29 to March 26 - April 1) can be easily managed with proper irrigation facilities. Cold temperate species (CTS) can not be grown in rain-fed as well as irrigated condition.

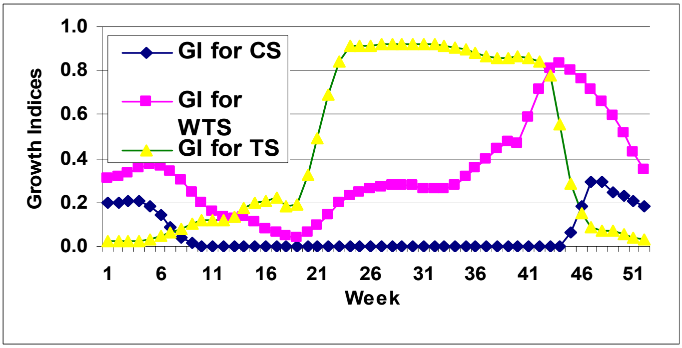

Fig. 9a: Growth Indices at Rampur in rain-fed conditions

Thus, only one crop as tropical species can be cultivated in the rain-fed condition for optimum yield during the summer monsoon as shown in Fig.9a. The second and third crop can be managed only by irrigation application as described earlier and is shown in Fig.9b. It is necessary to have short period of data such as weekly or decade to study the relation between crop and climate data, because normal (Long Term Average) and monthly data may be equal, but the rainfall may had fall within one or two days at the end of the month and where a long intervals of three to four week dry period may have wilted the crop. On the other hand, a short period of squall or hailstorm will just damaged the whole crop in the ground. FAO suggests 10 days period would be just right for crop weather analysis.

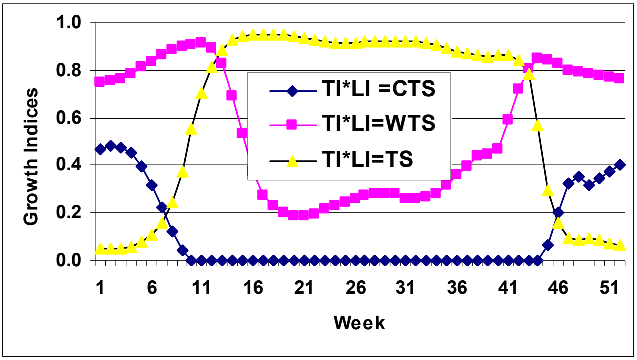

Fig. 9b: Growth Indices at Rampur in Irrigated conditions

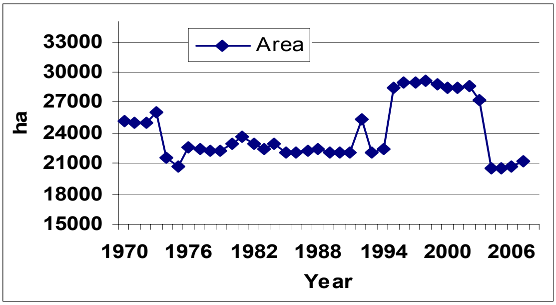

Fig. 10: Maize area in Chitwan

It is interesting to note that the maize yield in Tarai, Hills and Mountain justify the crop weather model patterns as described earlier. According to crop weather model, the Tarai is most favorable, the Hills and Mountain are relatively less favorable. The results were tallied by yield pattern in different ecological belt as discussed earlier.

In Nepal adaptation of modern farming technique and varietal improvement Maize started from Rampur Agricultural farm in Chitwan district during the early 1970's. A long time series of area, yield and production data of maize are only available at district level in Nepal.

Rampur comes under Chitwan district and therefore, Chitwan district data has been analyzed and presented here. The area of maize remained almost constant throughout 1974 to 1994, but 1995 to 2003 showed much higher in area and a later four years showed less (Fig.10). Why it was so, the reasonable explanation was not available. Similarly the yield showed decreasing tendency up to 1987 and later showed the increased trend as shown in Fig.11. The recent increase of increase of yield may not be only due to introduction of high yielding seeds, but may have been due to climate change factor. Discussions are very much required to draw any conclusion.

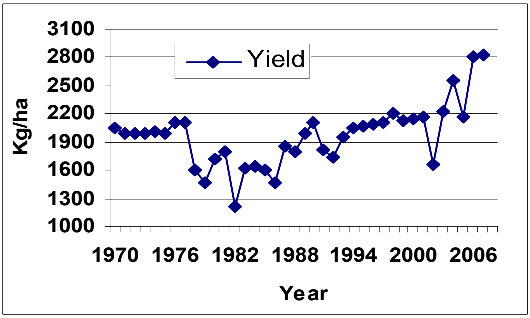

Fig. 11: Maize yield in Chitwan

This increase in maize yield is due to use of high yielding seeds which have been confirmed by personal discussion with the concerned authorities. While looking at the Fig.10, the cultivated area seemed just jumped during 1990's and later lower than the 1980's and therefore the concerned authorities should take note of this matter in future estimation. The production of maize in Chitwan district is shown in Fig.12

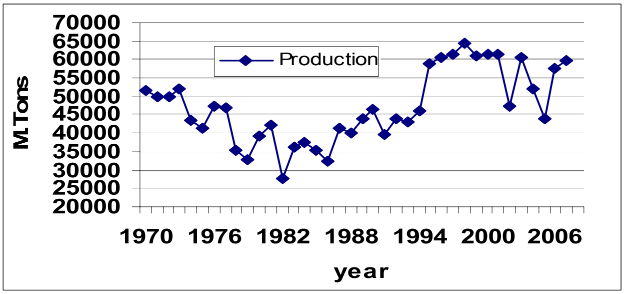

Fig. 12: Production of maize at Chitwan district

It is interesting to note that the shortfall of production of maize was noted in 1974, 1975, 1978, 1979, 1982, 1985, 1986, 1988, 1991, 1993, 1999, 2002 and 2005. This shortfall is as compared to the preceding year. The 13 years had shortfall of production out of thirty eight years. The decade rainfall and number of rainy days during that decade in the February to May during those years was presented in Table 1. The table indicates that the rainfall during the emergence period in all those years was very poor and therefore production may have been affected. When one relates the rainfall data with crops, the rainfall characteristics such as depth, intensity and distribution in time and space are all important factors.

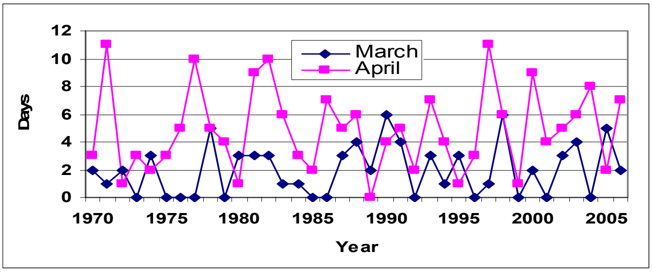

Fig. 13: Number of days of rainfall during March and April at Rampur

The water requirement of crops at the different stages, effective rainfall, water holding capacity of the soil and the crop coefficient are all required. Number of days of rainfall during those months of March and April and the amount of rainfall during those months are also presented in Fig.13 and 14. Similarly, the amount of rainfall during the months of May, June and July are also presented in Fig.15. If maize planted in May and June, this shows that the amount of rainfall and the soil moisture will be quite enough for emergence and vegetative period of maize, On the contrary, the rainfall in March and April is erratic and may not be sure to have enough soil moisture for emergence period.

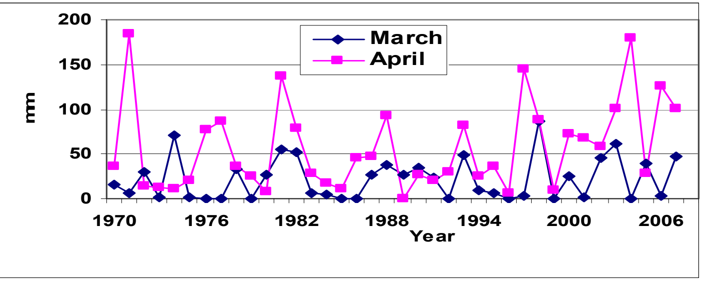

Fig. 14: Amount of rainfall during March and April at Rampur

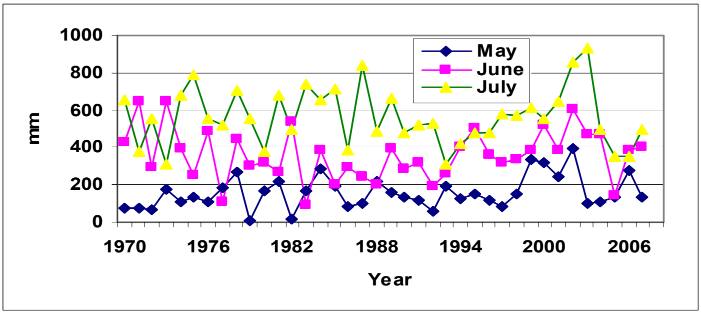

Fig. 15: Amount of rainfall during June, July and August at Rampur

Table 1: Decade Rainfall and rainy days >1.0mm in Rampur at the lower production year of maize

	February			March			April			May		
Year	Decade 1	Decade 2	Decade 3	Decade 1	Decade 2	Decade 3	Decade 1	Decade 2	Decade 3	Decade 1	Decade 2	Decade 3
1974	0.0/0	0.6/0	0.0/0	0.0/0	0.0/0	71.3/3	3.8/1	0.0/0	8.0/1	21.1/3	45.1/7	44.0/2
1975	10.0/3	4.3/1	0.0/0	0.3/0	0.5/0	6.4/1	0.0/0	0.0/0	21.1/5	0.0/0	65.8/5	66.3/5
1978	16.0/2	10.2/1	0.0/0	1.0/0	32.8/4	0.0/0	0.0/0	29.5/4	6.9/1	41.5/5	163.2/7	62.2/4
1979	7.7/1	7.0/1	0.0/0	0.5/0	0.2/0	0.0/0	1.5/1	12.4/2	10.6/1	0.0/0	1.7/1	6.8/1
1982	7.8/2	0.5/0	0.0/0	51.0/3	0.0/0	0.9/0	3.4/1	47.1/5	28.7/4	0.0/0	15.8/2	5.2/1
1985	11.1/1	0.0/0	0.0/0	0.0/0	0.0/0	0.0/0	5.2/1	0.0/0	6.2/1	21.5/4	89.9/6	83.0/6
1986	2.8/1	17.4/2	0.0/0	0.0/0	0.0/0	0.0/0	1.8/1	16.7/1	26.8/5	6.9/2	50.7/6	27.8/2
1988	0.0/0	0.8/0	1.9/1	12.2/1	26.0/3	0.0/0	0.0/0	53.7/3	38.5/3	16.9/3	69.9/5	133.6/7
1991	0.0/0	0.0/0	8.4/1	12.2/2	0.6/0	10.9/2	11.9/2	0.0/0	9.1/3	11.3/3	38.3/3	64.3/8
1993	0.0/0	9.1/1	0.0/0	0.0/0	0.0/0	49.4/3	0.0/0	55.4/3	27.1/4	48.8/2	73.5/6	63.2/4
1998	0.0/0	0.0/0	0.0/0	0.0/0	0.0/0	0.0/0	10.1/1	0.0/0	9.1/3	143.5/7	2.0/1	4.6/1
2002	0.0/0	13.2/1	15.1/2	11.2/1	0.0/0	34.4/2	10.5/1	0.0/0	40.0/4	104.4/5	168.3/7	119.2/5
2004	0.0/0	0.0/0	0.0/0	0.0/0	0.0/0	0.0/0	90.0/4	0.0/0	90.2/4	4.1/1	22.6/2	84.7/7
2005	2.2/1	1.4/1	1.2/1	0.0/0	35.6/3	3.3/2	0.0/0	0.0/0	28.7/2	36.1/2	83.6/5	13.8/3

CLIMATE CHANGE AND THEIR EFFECTS ON MAIZE

In the present scenarios of climate change, the impact on agriculture has to be explored and this is very enormous and complex task, but the country should immediately start planning and take action, before it is too late. The mean annual temperature trend at Rampur during 1968 to 2008 is shown in Fig.16. It showed that the increase of temperature seemed to be more in the recent decade than the former decade and the trend was 0.039^{0}C per year.

The maximum temperature trend at Rampur during the maize growing season from March to July was also analyzed as shown in Fig.17- 21. The trend of maximum temperature during April and May showed negative trend (Fig.18 and 19) and the month of June and July showed the positive trend as shown in Fig.17 and 18.

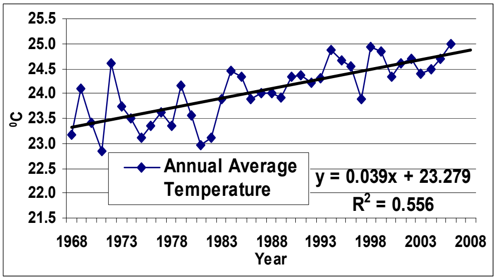

Fig. 16: Trend of annual average temperature

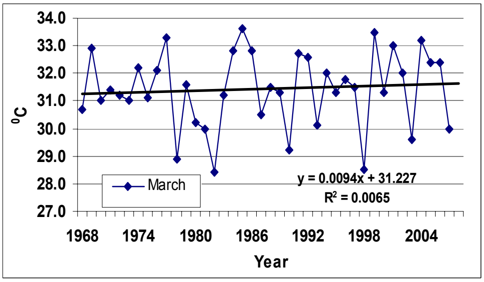

Fig. 17: Trend of maximum temperature during March

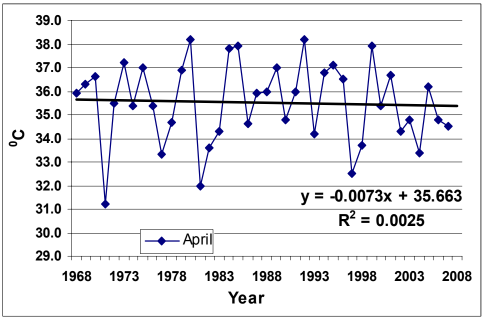

Fig. 18: Trend of max. temperature during April

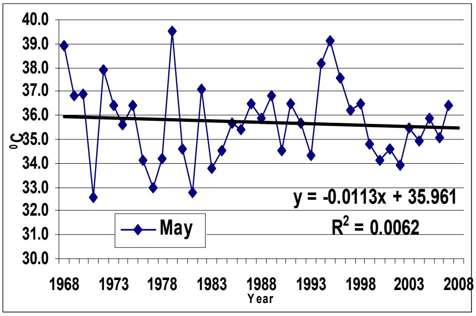

Fig. 19: Trend of max. temperature during May

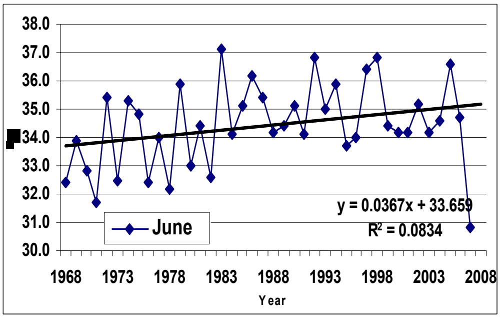

Fig. 20: Trend of max. temperature during June

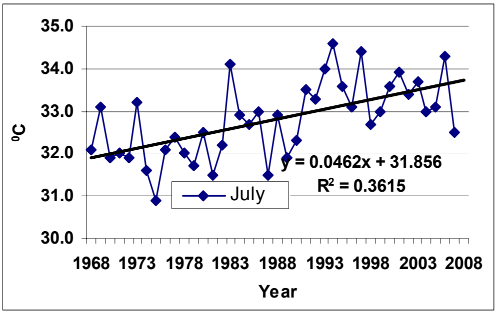

Fig. 21: Trend of max. temperature during July

Recently the effect of climate change to agriculture in Nepal was also studied by different researchers. The APN report shows, when the temperature rises up to 1^{0}C, there is a positive role in percentage change in maize yield in all the agro-ecological zones. When the temperature rises up to 2^{0}C and at the same time carbon dioxide is doubled, the yield will decrease in Tarai, Hills will not be much affected. On the contrary, Mountain environment will have better yield if the carbon dioxide is doubled and temperature rises up to 4^{0}C, the maize yield in Tarai will suffer 25% lesser than the present yield. Therefore the study of present variation of climatic parameters such as rainfall and temperature in the crop yield should be regularly studied and discussed.

PROBLEMS ENCOUNTERED

- Gray Leaf Spot is a great threat
- Gray leaf spot, a new disease of maize is a great threat in the mid hills of Nepal. Local varieties are more susceptible to this disease than improved varieties. Improved varieties such as Manakamana-3, Shitala, Deuti, Ganesh -1 and Ganesh -2 are less susceptible and thus these varieties need to be promoted in eastern and central hills of Nepal.
- Post harvest losses (storage)
- Post harvest losses due to diseases and storage pests should be minimized. Grain weevils are the major storage pest of maize in Nepal.
- Climate Change (Drought)
- Drought is prolonging year after year in Nepal. Development of drought tolerant varieties is the answer to the drought problem. Adjustment of planting season could help to escape the critical stage of crops to escape from the drought.
- One of the drought tolerant characters in a variety is having less anthesis and silking interval (ASI) in maize. Shorter ASI will escape drought in maize cultivation. Varieties with long ASI are more vulnerable to drought. In the context of climate change, development of drought tolerant varieties is one of the options to overcome the drought and answer to the problem of climate change.

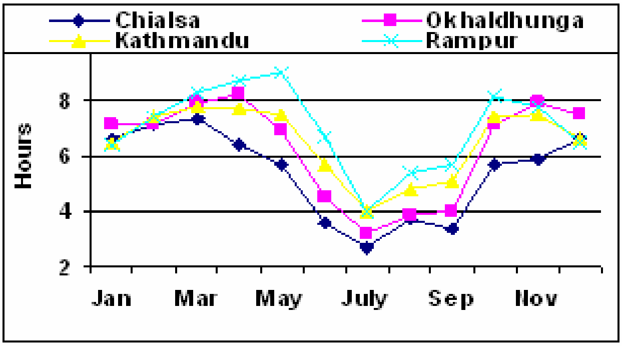

Fig. 22: Sun shine hours at the different places

DISCUSSION

- Despite the importance of maize, the yield has not been increased to satisfactory level. The production seemed to increase due to more land brought under cultivation he low yield of maize may be due to the following reasons.
- It is noted earlier that out of 38 years, 13 years had poor rainfall during the maize emergence period that affected maize production in those years.
- The second possible factor may be due to lower sunlight during the grain formation stage of maize and thereby, lower photosynthetic rate. Sunshine hours at Rampur, Kathmandu, Okhaldhunga, and Chialsa had low during July and August. During those months there is highest rainfall in Nepal. The long term average sunshine hours at Rampur, 256m; Kathmandu, 1336m, Okhaldhunga, 1720m and Chialsa, 2770 of Nepal at the different elevations are presented in Fig.22.
- During the maturity period, the high rainfall and high humidity caused maize disease such as BLSP and Turccicum blight resulting low maize production.
- Drought period is prolonging year after year in Nepal and same as the onset of monsoon. Planting of maize in rain-fed conditions depend upon the rainfall, one need to rethink on maize planting based on rainfall pattern. May to June planting and October/ November harvesting would be suitable for maize cultivation in Nepal. For this, experiment of maize planting on these months should be conducted.

RECOMMENDATION AND CONCLUSION

- The study of maize yield and production with relation to pre-monsoon rainfall (March-May) for the 1971-2008, through crude analysis, showed that maize yield in Chitwan was badly affected in thirteen years particularly in the years, 1974, 1975, 1978, 1979, 1982, 1985, 1986, 1989, 1991, 1993, 1999, 2002, and 2005. During those years the pre-monsoon rainfall was much below lower than normal rainfall. Therefore the impact of rainfall on maize yield and production is quite evident. Maize planting in the Chitwan should be adjusted according to the change in rainfall pattern in the recent decades.
- According to the crop weather model show in Fig.9a, the most favourable condition of tropical species at rain-fed condition lies in June to October and therefore the maize should be planted during that period.
- The present system of monitoring and evaluation of crop from Ministry of Agriculture and Cooperatives should be strengthened by updating the cultivated areas.

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INTEGRATED ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF NITROGENOUS FERTILIZER APPLICATION IN CANADIAN PRAIRIES

Suren Kulshreshtha[1]

ABSTRACT

Adoption of mitigation measures to reduce greenhouse gas emissions may affect other members of the society, producing a situation of trade-offs. In this study, such a trade-off is has been analyzed using three aspects of the Canadian society: producers (farm level adopter), environment (through reduction in the GHG emissions),; and regional economy (including rest of the society through lost / gained economic activities). The nutrient management strategy involving the switching nitrogen fertilizer application from a combination of fall and spring application to a 100 percent spring application. Results suggest that the adoption of such a measure creates a 'win-win' situation, being both environmentally and economically desirable. Under the scenario, fertilizer expenditures decreased by $43 million (giving rise to an equivalent increase in farm income), GHG emissions (in CO2E) by 2.15 percent of the 2000 level of emissions, Canadian economy as a whole showed improvements, although on a regional basis the results were mixed.

Key words: Canadian prairie agriculture, greenhouse gases, mitigation, nitrogen fertilizer use, trade-off analysis.

INTRODUCTION

In 1997 Canada signed the Kyoto Protocol and committed to a six percent reduction in greenhouse gas (GHG) emissions from the 1990 level. With the proceedings of the 2009 Copenhagen Accord, this commitment is no longer a binding, but it will mostly likely be replaced by a new commitment[2]. In the mean time, Canadian GHG emission levels have been increasing. For example, in 1990 Canadian GHG emissions were estimated to be at 596.0 megatonne (Mt) Carbon Dioxide Equivalent (CO_{2E}), which by 2007 rose to 747 Mt – an increase of 25.3 percent% over the 1990 level (Environment Canada, 2009). Although emissions are increasing now at slower rates than during 1990-2000 period, as shown in AppendixAnnex 1, by 2020 Canadian GHG could reach 824 Mt CO_{2E}. Under the present commitment, this would mean that emissions would have to be reduced by 217 Mt CO_{2E} or 29 percent% of the 2005 level.

Canada's commitment to reduce GHG at some future date requires some knowledge of its likely impact on the society either directly or through environmental aspects. Many previous studies have examined the potential impact of agriculture mitigation measures in reducing GHG emissions. For example, study of GHG mitigation measures have been reported by Sims (2003), and Tuhkanen, Lehtila, and Savolainen et al. (1999). Sims (2003) investigated the role played by bioenergy in mitigating GHG emissions, and identified economic, environmental and social benefits from bioenergy development, trade-offs from such adoption were neither identified nor measured. Similarly, other studies have focused on environmental impacts, while overlooking economic impacts resulting from their implementation. Examples of such studies include Babcock et al. (2001), Baker and Murray, (2009), Riedacker, (2007), Flessa et al., (2002), Pant, (2009)). Carbon sequestration has also been studied by Stinson and Freedman (2001), and Marland, Schlamadinger and Canella

[1] Department of Bioresource Policy, Business and Economics, University of Saskatchewan, Saskatoon, Canada, Email: suren.kulshreshtha@usask.ca.

[2] Recent announcement by the Government of Canada indicates that the new deal may be to reduce GHG emissions from the Canadian economy by 17% of the 2005 level by 2020.

et al. (1997). Such sequestration measures are complementary to mitigation measures since they all lead to either permanent or temporary reduction in the level of GHG emissions. For example, use of zero tillage is a common mitigation measure endorsed for such sequestration activities, which could conceivably crate create trade-off situation. Other studies have also investigated waste management (Pipatti and Wihersaari, 1997-1998), but with no assessment of trade-offs.

In Canada, Khakbazan et al. (2004) have evaluated the performance o of two farming systems in terms of their GHG emissions, with no economic or social impacts considered. Meyer-Aurich (2004) reported best management practices that reduce GHG emission in eastern Canada. A similar study by Smith and Upadhyay (2005) reported such practices on diversified farms in western Canada. These studies have addressed only the biophysical aspects of mitigation and sequestration.

Linking agriculture with environment and some social issues, such as poverty reduction, has been reported by Dhakal (2007) and recommended that projects need to examine economic impacts before their final selection. However, there appears to be a need for examining various measures from both bio-physical (leading to environmental) and economic perspectives to examine the possible trade-offs.

Many decision makers are reluctant to recommend a wide adoption of mitigation measures on grounds that it might slow down the economic activities in their own jurisdiction[1]. This suggests that perhaps for some mitigation measures a trade-off situation may exist. These trade-offs may be in the form of better environmental performance, but at the cost of poor regional economic growth. Examination of such trade-offs for measures designed to reduce agricultural GHG emissions is thus important for policy makers. Such an examination involves development of an analytical framework capable of identifying these trade-offs with the purpose that proper policies and programs can be developed with their likely consequences known a priori before their adoption is endorsed.

Industrial agriculture world over is heavily dependent on the use of inorganic fertilizer to supply crop nutrients. This, on one side, improves the farm cash position but on the other, manufacturing and distribution of fertilizer creates jobs in the regional economy. However, application of fertilizer has impacts on the environment through increased GHG emissions, as well as affects air and water quality.

The purpose of this study was twofoldthreefold to: 1) To estimate the GHG emissions resulting from change in nitrogen fertilizer use on the Canadian prairies; 2) To estimate the economic impacts resulting from the changed nitrogen fertilizer use mitigation scenario; and 3) Eexamine the situation of trade-offs that may be created through adoption of these mitigation practice.

SALIENT FEATURES OF NITROGEN FERTILIZER USE IN CANADIAN AGRICULTURE

Canada's consumption of nitrogen based fertilizers on a global scale was ninth in 2002 at 1.63 Mt (1.9 percent) (FAOSTAT Data 2005), with the majority of the consumption being dominated by agricultural activities. When estimated on per capita basis Canada's nitrogen fertilizer consumption was third at 52.12 kg per capita[2]. Only Ireland and New Zealand had higher per capita nitrogen fertilizer consumption. The trend in fertilizer use in Canada has increased significantly since 1990 as shown in Fig.1. Although fertilizer sales have slowed

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[1] One of the arguments frequently given in Canada is that the country cannot afford an aggressive mitigation campaign during the current period on account of current recession.

[2] Most of the fertilizer sales are for agricultural production. However, it is acknowledged that a small part of this total may also be used by home gardens and other non-agricultural purposes.

down a little during the last decade[1], if the historical trend in nitrogen based fertilizer consumption in Canada were to continue to 2020 period the estimated level of nitrogen fertilizer consumption would be higher than current levels. This significant increase in nitrogen fertilizer consumption for the year 2020 would result in a substantial increase in GHG emissions from nitrogenous fertilizers. Consequently, mitigation scenarios involving nitrogen fertilizer consumption in Canada have become increasingly important.

The regional distribution of Canadian nitrogen fertilizer consumption in 2000 was dominated by the prairie provinces of Alberta, Saskatchewan and Manitoba (Fig.2). These three provinces combined for 82 percent of the total nitrogen fertilizer consumed in Canada in 2000[2]. Saskatchewan was responsible for 33 percent of the consumption, while Alberta and Manitoba consumed 30 percent and 19 percent, respectively. The dominance of the three Canadian Prairie provinces in nitrogen fertilizer consumption would ultimately lead to a prairie focused nitrogen fertilizer mitigation scenario.

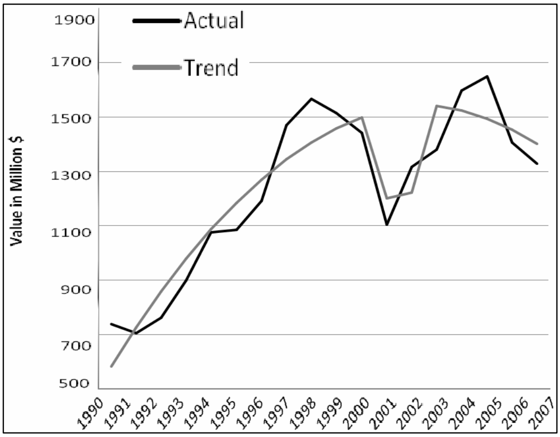

Fig. 1: Total Canadian nitrogen fertilizer consumption from 1990 - 2007
Source: Estimated from Statistics Canada (2010a and b)

METHODOLOGY

Most decision makers operate within a multi-decision framework. Here, the decision maker has several criteria that need to be achieved by a given mitigation measure[3]. A situation of a trade-off exists when the decision maker must sacrifice (or accept lower performance for) at least one criterion in order to achieve a gain in another criterion. In contrast, a 'win-win' situation is where all the criteria of the policy maker are met at some acceptable or superior level.

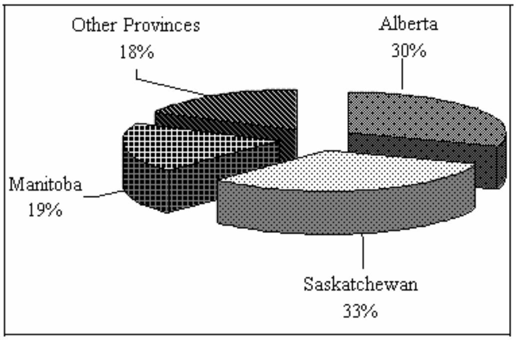

Fig. 2: Provincial distribution of N- fertilizers in Canada in 2000 (Korol and Rattray, 2001

In this study trade-offs were assessed using three criteria: – change in the farm level economics for the adopter of the GHG mitigation measure; reduction in the level of GHG emissions; and change in the level of regional economic activities. Using these three

1 Two reasons for this could be advanced: One, the droughts of 2001 and 2002 reduced the need for fertilizer since certain areas were not seeded and farmers' paying capacity was reduced; Two, in more recent period, price of fertilizer increased significantly.

2 Data for recent time period has been suppressed by Statistics Canada to preserve confidentiality. Therefore, data for the year 2000 are used. It is expected that the pattern of use has not changed appreciably since that time.

3 In fact, the same could be said about any policy measure.

criteria one can distinguish between a trade-off and a win-win mitigation measure as shown in Fig.3. The base scenario triangle stands at 100 %percent of the baseline situation. The dotted-line triangle on the left-hand side of the diagram shows gain in all three criteria, and thus is labeled a 'win-win' scenario. On the other hand, in the third scenario there is a desirable change in GHG emissions, but a loss to the producers. This illustrates that there is a trade-off between environment and farm level economics.

In order to assess the trade-off in the study mitigation practice, three separate but compatible models were interlinked: (1) Canadian Regional Agriculture Model (CRAM); (2) Greenhouse Gas Emissions Model (GHGEM) for Canadian Agriculture,; and (3) Canadian Agriculture Regional Disaggregated Input Output Model (CARDIOM). An overview of trade-off analysis is shown in Fig.4. Each of these is described below.

CANADIAN REGIONAL AGRICULTURE MODEL (CRAM)

The CRAM is a static non-linear economic optimization model that maximizes a modified welfare function (consumer plus producer surplus less processing and transportation costs) through allocation of agricultural resources and land subject to model constraints facing various sectors of the Canadian agricultural economy (Horner et al., 1992). It allows for both inter-provincial trade and international trade in primary and processed products. The basic commodity coverage is grains and oilseeds, forage, beef, hogs, dairy and poultry.

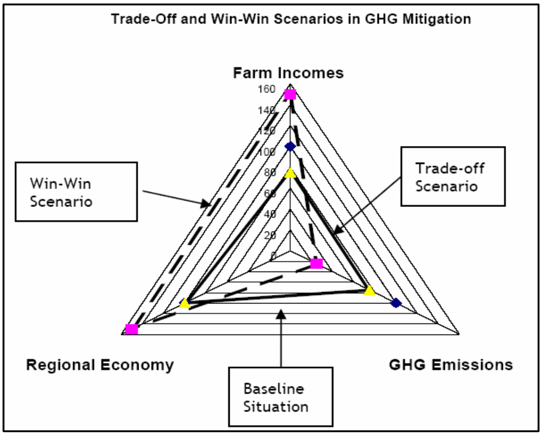

Fig. 3: Diagrammatic representation of a trade-off and a win-win mitigation scenario with three criteria

The model includes both crop and livestock production, with crop activities being disaggregated into 55 regions and livestock activities disaggregated provincially. The CRAM includes both inter-provincial and international trade in primary and processed agricultural products. The analysis of mitigation scenarios in the CRAM are conducted by comparison of scenario and baseline activity levels. The outputs of the model include level of activities for crops and livestock enterprises, and their respective input use under a given scenario.

GREENHOUSE GAS EMISSIONS MODEL (GHGEM)

The second sub-model GHGEM is a modular static linear additive calculator of GHG emissions that is linked to the CRAM output. In other words in the absence of the CRAM the GHGEM is unable to produce any results. The GHGEM estimates both backward and forward (food processing and transportation) linkages resulting from agriculture production. More details on the models are presented in Sobool and Kulshreshtha (2005). The accounting structure of the GHGEM is shown in Annex 2.

The GHG emissions are measured at three levels, namely, 1) Intergovernmental Panel on Climate Change (IPCC) level emissions, 2) Total direct farm-level emission, and 3) Agriculture and Aagri-food sSystem (AAFS) level emissions. The GHGEM is designed to estimate the GHG emission that are both directly and indirectly related to agriculture activities. For example the use of fertilizer at the farm level results in IPCC level emissions, namely fertilizer application emissions as well as atmospheric deposition and leaching of nitrogen, but to account for the entire AAFS the production and transportation of fertilizer from the manufacturing plant to the wholesaler (distributor) must be included. These indirect emissions are referred to as backward linkages.

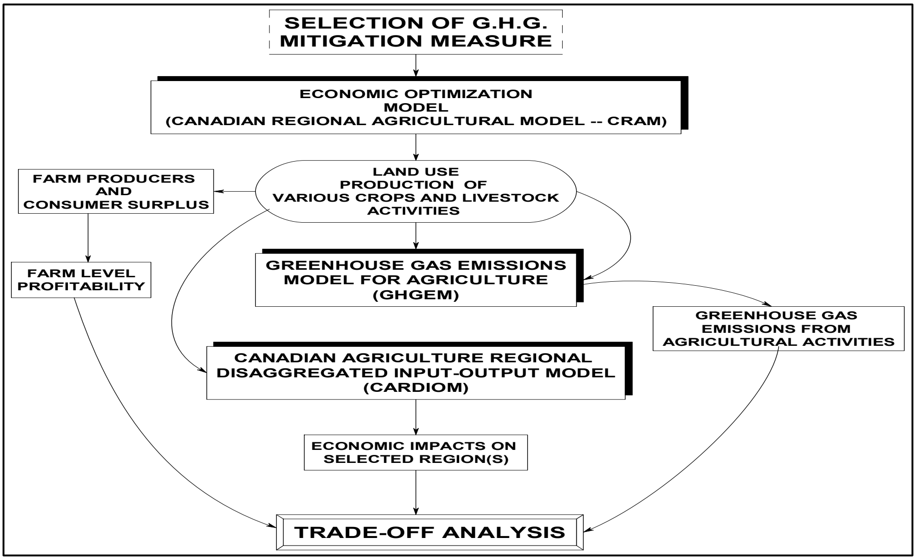

Fig. 4: Overview of trade-off analysis

CANADIAN AGRICULTURE REGIONAL DISAGGREGATED INPUT OUTPUT MODEL (CARDIOM)

The estimation of the regional economic impacts resulting from the reduced nitrogen fertilizer use scenario involves using the CARDIOM (Sobool and Kulshreshtha, 2006). The CARDIOM is an input-output (I-O) model for the entire Canadian economy disaggregated at the provincial level. The change in economic indicators (such as include value of sales of goods and services, gross domestic product, household incomes, imports from other parts of the world, and employment). Value of sales was estimated from the results of the CRAM, which are converted to the input format of the CARDIOM through an interface module.

The basic structure of the I-O model is based on the transaction tables maintained by Statistics Canada (2001). The main constraint to the Statistics Canada provincial I-O tables was that the agriculture sector was limited to a single industry with only two commodity classifications, while the manufacturing sector was not divided into food and non-food sectors and was limited to four food commodity classifications. To overcome this constraint the CARDIOM disaggregated the agriculture sector into 13 farm types and 11 commodity classifications. The manufacturing sector was divided into 9 nine food and beverage sectors and one non-food manufacturing sector.

The CARDIOM estimates two types of economic impacts resulting from the direct impact data generated through CRAM-Interface module. This model then calculated indirect (called Type I) and induced (Type II) impacts. For example, in a fertilizer scenario, reduction in the fertilizer expenditures, and resulting change in the gross revenues and farm net incomes, are the direct impacts. This reduced demand for nitrogen fertilizer would result in indirect impacts, such as lower output of the fertilizer manufacturing sector. This would trigger lower input demand for this sector, including lower employment of workers. This would result in a chain reaction of lower demand for various goods and services in the economy, including loss of employment of workers. The induced impacts are the economic impacts result from change in employment (and thus the household income) first, and then through change in their respective expenditures on goods and services. In the reduction of nitrogen fertilizer scenario, the induced effects would result mainly from change in farm net income and from change income of the workers engaged in various industries affected under the scenario.

SCENARIO DESCRIPTION – NITROGEN FERTILIZER MATCHING

Most producers apply fertilizer either in the fall or in the spring season. Some of the fertilizer so applied finds its way to the atmosphere through atmospheric deposition or leached to underground receptacles (such as shallow aquifers).

The scenario utilized for estimation of trade-off (or a win-win) situation in reducing GHG emissions from agriculture. The study scenario assumes that current nitrogen fertilizer application on the Canadian prairies is inefficient with respect to its time of application. A typical practice is to have a split application – 30 percent applied in the fall previous to the crop season, and 70 percent as spring application. Spring application of nitrogen fertilizers is considered to be more efficient in terms of nutrients available for crop growth. Thus, shifting away from the fall application improves the technical efficiency of fertilizer used, and therefore, a smaller quantity is required to maintain the same level of yield. However, the downside of this change is that the cost of fertilizer is relatively higher during spring application period than in fall. On average, a 12 percent price premium was noted for spring application (Heigh and Junkins, 2004).

ASSESSMENT OF SCENARIO IMPACTS

The scenario was analyzed first using the CRAM. Change in the amount of fertilizer and the price paid by producers under the study scenario were estimated. More details on this analysis are presented in Heigh and Junkins (2004). The results from the CRAM were then used in the Interface Module to convert these results into the input-output I-O model final demand. The change in nitrogen fertilizer input demand values were then inputted into the GHGEM and CARDIOM to estimate the resulting GHG emissions and economic impacts, respectively, from the reduced demand for nitrogen fertilizer has in the prairie and Canadian economy.

RESULTS

The results of the nitrogen fertilizer reduction scenario were examined with respect to their environmental and economic efficiencyies. The first section reports farm level economics under the study scenario. This is followed by an assessment of environmental efficiency of the reduced nitrogen fertilizer scenario in terms of change in the GHG emissions. The third section examines the economic efficiency of the nitrogen fertilizer mitigation scenario in terms of regional impact analysis.

FARM LEVEL IMPACTS

Reduction in the level of fertilizer applied to the crops with no associated change in the yield of various crops resulted in reduced expenditures on fertilizer of $43 million annually in 2006 dollars. Other crop production related expenses remain unchanged. Given that gross revenue does not change under this scenario, the net result is a gain in producer surplus (equivalent to net farm income) of an equivalent amount, as shown in tTable 1.

GREENHOUSE GAS EMISSIONS

The nitrogen fertilizer reduction scenarios effect on GHG emissions on the Canadian prairies are shown in Ttable 2. These reductions were a result of both IPCC level (and farm level) as well as at the agri-food system level emissions. These emissions were from three main sources: direct emissions from the fertilizer use,; ecosystem level emissions from atmospheric deposition and leaching,; and manufacturing and transportation of fertilizer.

Table 1. Nitrogen fertilizer scenario change in physical and monetary demand, based on CRAM output, 2006

Province	Change in fertilizer consumption (t)	% Change in fertilizer consumption from Without Scenario Levels	Change in fertilizer input demand ($'000)
Alberta	-36,795	-7.2%	-$15,360
Saskatchewan	-32,229	-5.9%	-$14,320
Manitoba	-26,091	-8.0%	-$13,470
Total Prairies	-95,115	-6.9%	-$43,150

Table 2. Net change in GHG emissions from fertilizer reduction scenario, in kilotonnes of CO_{2E}, 2006 level

Category	Alberta	Sask.	Manitoba	Total
IPCC Emissions				
Fertilizer	-114.54	-99.03	-100.01	-313.57
Atmospheric Deposition	-17.92	-15.70	-12.71	-46.33
Nitrogen Leaching	-67.22	-58.88	-47.66	-173.75
Total Net IPCC Emissions	-199.68	-173.61	-160.38	-533.66
% Reduction in IPCC Emissions, %	-1.35%	-1.44%	-2.19%	-1.56%
Agri-Food Sector (AFS) Emissions				
Fertilizer Production -- Domestic Use	-217.12	-102.95	-57.92	-377.99
Transportation from plant to dealers	-5.74	-9.63	-1.02	-16.39
Total Net AFS Emissions	-222.86	-112.58	-58.94	-394.37
% Reduction in AFS Emissions, %	-2.02%	-2.63%	-3.59%	-2.48%
Agriculture and Agri-Food Sector (AAFS) Emissions				
Total Net Emissions for the AAFS	-422.53	-286.19	-219.31	-928.03
% Reduction in Total AAFS Emissions, %	-1.80%	-2.15%	-3.02%	-2.15%

For the entire agriculture and agri-food sector in the Canadian prairies, GHG emissions decreased by 928.03 kilo tonnes[1] (kt) in Carbon Dioxide Equivalent[2] (CO_{2E}), which was 2.15 percent lower than that under the base situation[3]. Largest reduction among the three Prairie Provinces was recorded for Alberta at 422.53 kt of CO_{2E} (constituting a reduction of 1.80 percent from the base situation), followed by Saskatchewan at 286.19 kt (2.15 percent lower than the base situation) and finally Manitoba at 219.31 kt (3.02 percent below the base situation).

Little over a third of the total GHG emissions are from reduction in the application of fertilizer, as shown in Fig.5. The largest reduction in the total GHG emissions is through reduced production (manufacturing), storage and transportation of the fertilizer.

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1 A kilo-tonne is 1,000 tonnes, which is equivalent to one giga gram (10^{12} g).

2 Carbon dioxide equivalent level of greenhouse gases is obtained by multiplying each gas by its global warming potential (GWP) relative to carbon dioxide. In this study, for methane and nitrous oxide GWP of 21 and 310, respectively, was used.

3 The base situation was that for the farms when the study scenario is not implemented.

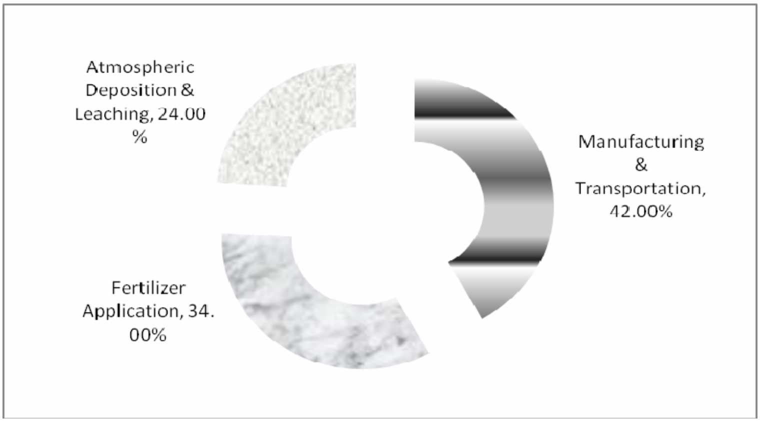

Fig. 5: Distribution of total reduction in GHG emissions under study scenario

REGIONAL ECONOMIC EFFECTS

The economic impact results from the fertilizer matching scenario are shown in tTable 3. The results are divided provincially for the prairie region, with aggregate totals for the prairie region and Canada being presented as well. Given the CARDIOM is a multi-regional model the feedback effects are estimated directly. The estimation of the aggregated national feedback effects using the CARDIOM is estimated as the difference between the national economic impact results and the study region results.

As noted above, Type I impacts are a sum of direct and indirect impacts, the latter being created through backward linkages of agricultural production. The Type II impacts include, in addition to Type I impacts, those created by spending of household income on the goods and services. For the prairie region a decrease in fertilizer demand of $43.15 million results in loss of direct and indirect impacts on output for the Canadian economy is $25.74 million. When factoring in the induced impacts of increased household spending, specifically farm households whose income increased by the same level of the decreased fertilizer demand as shown in Ttable 43, the total economic impact results in increased output of prairie firms by $18.20 million. The national level of total economic impact resulted in an increase in the national output of $9.19 million. The fact that the prairie region total economic output level is $9.02 million higher than the national value indicates that the feedback loss effects are greater outside the prairie region mainly due to the high level of fertilizer imports in the prairie region. The increase in type I[1] household income of $36.79 million on the prairies results in the GDP at market prices to increase $30.67 million, while including the induced impacts results in total prairie income increase of $51.09 and GDP at market prices increasing $55.79 million. The feedback loss effect for the rest of Canada shows thant total household income decreased $4.11 million, resulting in GDP at market prices declining $5.52 million.

The effect the fertilizer scenario has on employment results in a loss of 191 jobs directly and indirectly (through backward linkages). Inclusion of the induced impacts results in total employment increasing by 282 jobs for the prairie provinces. For Canada as a whole the

[1] Type I economic impacts is estimated when the household incomes are not endogenous. Thus, change in the income of producers has no impact on the regional economy. This is modified in the Type II impacts, which are estimated using household incomes made endogenous in the model.

direct and indirect jobs losses are 396 workers, while the total number of jobs in Canada increased by 135. The feedback loss effects for the non-prairie region yields a loss of 205 jobs under the type I impacts, while overall the number of non-prairie jobs fell by 147.

Table 3: Economic iImpact aAnalysis rResults for the fFertilizer sScenario, 2006

Parameter	Output ($ Mill.)	GDP at Market Price ($ Mill.)	Household Income ($ Mill.)	Employment (FTE # of Workers)
Alberta				
Direct Economic Impact	($15.36)			
Direct & Indirect Impacts	($12.13)	$10.38	$12.73	(65)
Induced Impacts	$17.43	$9.69	$5.56	158
Total Impacts	$5.30	$20.07	$18.29	93
Saskatchewan				
Direct Economic Impact	($14.32)			
Direct & Indirect Impacts	($6.44)	$11.02	$12.90	(48)
Induced Impacts	$13.76	$7.87	$4.36	162
Total Impacts	$7.32	$18.86	$17.26	114
Manitoba				
Direct Economic Impact	($13.47)			
Direct & Indirect Impacts	($7.18)	$9.27	$11.16	(78)
Induced Impacts	$12.76	$7.59	$4.38	153
Total Impacts	$5.58	$16.86	$15.54	75
Prairies				
Direct Economic Impact	($43.15)			
Direct & Indirect Impacts	($25.74)	$30.67	$36.79	(191)
Induced Impacts	$43.95	$25.12	$14.30	472
Total Impacts	$18.20	$55.79	$51.09	282
Non-Prairie Region				
Direct & Indirect Impacts	($21.62)	($10.89)	($7.60)	(205)
Induced Impacts	$12.60	$5.37	$3.49	58
Total Impacts	($9.02)	($5.52)	($4.11)	(147)
Canada				
Direct Economic Impact	($43.15)			
Direct & Indirect Impacts	($47.37)	$19.78	$29.20	(396)
Induced Impacts	$56.55	$30.49	$17.79	531
Total Impacts	$9.19	$50.27	$46.98	135

The overall results indicate that the prairie economy positively benefits from the reduced nitrogen fertilizer demand, with increased output, GDP at market prices and increased employment. When factoring in the feedback loss effects for the non-prairie region the total economic impacts for the entire Canadian economy are still positive, despite the economic loss experienced in the non-prairie region.

CONCLUSIONS

This paper estimated the environmental and economic impacts resulting from a reduction in the use of agricultural nitrogen fertilizer on the Canadian prairies resulting from the switching to a 100 percent spring application using three models. The impact on the farm level resource allocation were estimated using CRAM, while t he environmental impacts were estimated using the GHGEM. Finally the economic impacts were estimated using CARDIOM. The estimation of both the environmental and economic impacts from the nitrogen fertilizer mitigation scenario allowed for estimation of any potential trade-offs between regional development and GHG mitigation. This trade-off analysis is important as when examining the overall societal effects of a mitigation scenario as a reduction in GHG emissions may result in significant financial costs to society.

The nitrogen fertilizer reduction scenario is both environmentally and economically feasible. The total reduction in nitrogen fertilizer consumption on the Canadian prairies was over 95.1 kt (6.9 percent), while the resulting decreased demand resulted in a decrease in fertilizer expenditures of $43.15 million. The reduction of CO2E GHG emissions for the Canadian prairies was 928.03 kt from the baseline levels. This was a reduction of 2.15 percent. The IPCC level CO2E emissions declined 533.66 kt (1.56 percent) and the AAFS emissions were reduced 394.37 kt (2.48 percent).

The non-prairie regions of Canada experienced a decline in economic development from the reduced fertilizer demand but the increase in the prairie region was significant enough to offset the non-prairie region loss. The economic impacts resulting from of the reduced fertilizer demand resulted in increased GDP at market prices of $50.27 million. Household income in Canada increased by $46.98 million and there were 135 new jobs were created. The direct and indirect impacts to the prairie and Canadian economy suffered a loss from the reduced fertilizer demand but the increase in the induced impacts, which were driven by increase in farm level income, generated enough economic spin-offs to result in an overall net gain to the society.

The results from both the economic and environmental analysis show that both are efficient in increasing societal welfare. While the results are significant on an absolute scale, in relative terms these are borderline insignificant. This does not mean, however, that the reduction of in nitrogen fertilizer use on the Canadian prairies should be ignored but rather the feasibility of expanding the scope and size of the scenario to both further decrease nitrogen fertilizer use and include other provinces should be examined. Nonetheless, examination of changes in both economic and environmental parameters is of interest to the decision makers, and for this reason an assessment should be based on the proposed integrated manner.

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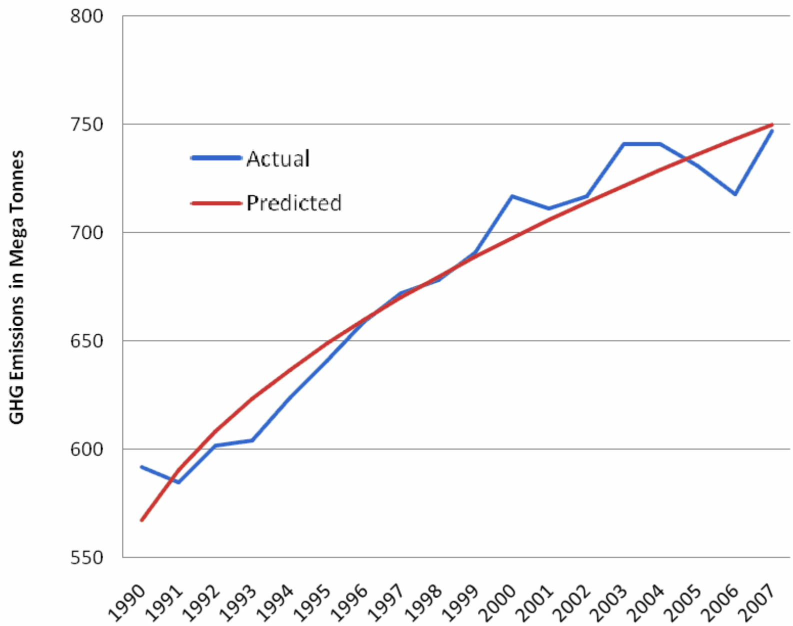
Annex 1: Greenhouse gas emissions from the Canada economy



A trend equation was estiamted using a square-root transformation applied to the 1990-2007 data restutled in the following equation:

$$GHG_t = 510.94 + 56.29\ (TIME_t)^{0.5}$$

(10.39) (3.37)

R^2 (Adj- R^2) = 0.946 (0.942) S_e = 13.46 F = 278.48 n= 18

Where, GHG =Actual greenhosue emissions from the Canadian economy in mega tonnes (Mt);

TIME= Trend variable starting from 1990 =1, …, 2007=18.

Both the coefficients were significantly diifferent from zero at 1%.

The above equation was used to predict 2020 GHG emissions from the Canadian economy, and were estimated at 824 Mt.

Given that 2005 level of emissions were 731 Mt, a 17% reduction comittment by Government of Canada would translate into 2020 emissions being 607 Mt. This would result in a reduction target of 217 Mt, or 29% of the 2005 GHG emisions level.

Annex 2: Accounting structure used in the GHGEM

Module	Activity	CO_2	CH_4	N_2O
(1) Crop Production	1) Crop Residues			X
	2) Fertilizer			X
	3) Nitrogen-Fixing Crops			X
	4) Soil Organic Matter -- Source	X		
(2) Livestock Production	5) Farm Animals		X	
	6) Animal Excretion -- Manure		X	X
	7) Animal Excretion -- Grazing			X
	8) Animal Excretion -- Manure Storage			X
(3) Indirect Agroecosystem	9) Atmospheric Deposition -- Fertilizer			
	10) Atmospheric Deposition -- Manure			X
	11) Nitrogen Leaching -- Fertilizer			X
	12) Nitrogen Leaching -- Manure			X
	13) Histosols	X		X
	14) Human Sewage			X
(4) Direct Agroecosystem	15) Agricultural Soils uptake		X	
	16) Waterlogged lands		X	
Aggregation 1: IPCC Agriculture Level Emissions	Sum of Modules (1) to (4)			
(5) Other Farm Level Production	17) Fuel for Farm Machinery and Equipment	X	X	X
	18) Soil Organic Matter -- SINK	X		
(6) On-farm Transportation and Stationary Combustion	19) On-Farm -- Crops -- Transportation	X	X	X
	20) On-Farm -- Crops -- Other Uses	X	X	X
	21) On-Farm -- Livestock Transportation	X	X	X
	22) On-Farm -- Livestock -- Other Uses	X	X	X
Aggregation 2: Direct On-Farm Level Emissions	Sum of Modules (1) to (22)			
(7) Farm Inputs	23) Manufacturing, Transportation, and storage of fertilizer	X	X	X
	24) Manufacturing, Transportation, and Storage of Fuel	X	X	X
	25) Manufacturing, Transportation, and Storage of Pesticides	X	X	X
	26) Manufacturing, Transportation, and storage of machinery/implements	X	X	X
(8) Off-farm Transportation and Storage	27) Off-Farm Transportation of Crops	X	X	X
	28) Off-Farm Transportation of Livestock	X	X	X
	29) Storage of Crops	X	X	X
(9) Food processing and related activities	30) Meat and Poultry	X	X	X
	31) Dairy Products	X	X	X
	32) Fruits and Vegetables	X	X	X
	33) Bakery Products	X	X	X
	34) Other Food Products	X	X	X
	35) Breweries	X	X	X
	36) Other Beverage Industry	X	X	X
Aggregation 3: Agriculture and Agri-Food System Level Emissions	Direct Farm-level Emissions plus sum of activities (23) to (36)			

Source: Sobool and Kulshreshtha (2005).

AGRICULTURAL INTENSIFICATION: LINKING WITH LIVELIHOOD IMPROVEMENT AND ENVIRONMENTAL DEGRADATION IN MID-HILLS OF NEPAL

Nani Raut[1], Bishal Kumar Sitaula[2] and Roshan Man Bajracharya[3]

ABSTRACT

This article reviewed on agricultural intensification from livelihood and environment perspectives in mid-hills of Nepal. Agricultural intensification has provided improved economy, food security, employment opportunities, decision-making, labor division, local institutions and leaderships. But soil degradation has been accelerated along with greenhouse gases emission. Additionally, the potential linkages of agricultural intensification to degradation and pathways for marginalization in the long run are addressed. However, the catalytic role of institution and farmers' perception on intensification are equally important. To ensure socio-economically and environmentally sound production, sustainable agricultural intensification guided by good institutional systems is recommended.

Key words: Agricultural intensification, greenhouse gases, institution, livelihood, soil degradation

INTRODUCTION

Agricultural development has emerged as a major subject of development discourse in livelihood improvement and environment degradation in Asia. Shifting cultivation, the first stage of agricultural development was the most widespread agricultural system in South and Southeast Asia until the mid-20th century (Spencer, 1966). It involves basic tools and techniques, low level of inputs and subsistence level of production and consumption (Rasul and Thapa, 2003), which was unable to support growing population and their subsistence needs.

The food security situation was worse in developing countries where the colonial power invested very little on food production systems. After independence, their situations were much worse. The increasing population combined with government control over common property resources was putting pressure on shifting cultivators to reduce the fallow period (Palm et al., 1996 and Gafur et al., 2000). Meantime, shifting cultivators deserve improved lifestyle which was not possible from the low return being provided by their practice of cultivation. Such circumstances forced farmers to seek for more productive agricultural system which otherwise could have brought a hunger and malnutrition situations in Asia. The "*crisis*" was realized by U.S. President's Science Advisory Committee and came up with a report in 1967. The report concluded that "the scale, severity and duration of the world food problem are so great that a massive, long-range, innovative effort unprecedented in human history will be required to master it" (IFPRI, 2002). In response, Ford Foundation and Rockefeller initiated in establishing the international agricultural research system in order to transfer scientific advances. These advances including high yielding varieties, more use of chemical fertilizers, irrigation and other chemical inputs led to a remarkable yield in Asia in the late 1960s. Such a radical change from hunger situation to dramatic increased yield situation is coined as *"Green Revolution"*.

[1] Dept. Int. Env. and Dev. Studies (Noragric), Agri. Uni. of Norway, P.O. Box 5001, N-1432 Ås, Norway Ph.: +47 64965340, fax: +47 64965201, E-mail: nani.raut@umb.no
[2] Dept. Int. Env. and Dev. Studies (Noragric), Agri. Uni. of Norway, P.O. Box 5001, N-1432 Ås, Norway
[3] Dept. of Env. Sci. and Eng., Kath. Uni., P. O. Box 6250, Dhulikhel, Nepal

The objective of the paper is to review and link agricultural intensification from livelihood and environment perspective in the mid-hills of Nepal. It describes improvement in livelihood through the economic, social and institutional indicators and deterioration of environment through soil degradation and greenhouse gases emission. The paper links and discusses agricultural intensification to the degradation and marginalization thesis.

EVOLUTION OF AGRICULTURE DEVELOPMENT IN NEPAL

Shifting cultivation in Nepal was extensively accomplished by the beginning of the 11th century until 19th century. By the end of 19th century, it was almost substituted by permanent type of agriculture (Rasul and Thapa, 2003). During the Rana regime (1846-1951), there were no serious attempts made until 1930 for systematic initiation of economic development. In 1937, a development agency was constituted called as '*Udyog Parishad*' (Development Board), the major purpose of which was to promote the growth and extension of agricultural, industrial and commercial activities in the country. The Development Board was soon tracked by specialized development agencies, one of which was Agricultural Council (National Planning Commission, 2002). It was established with the objectives of improving farming techniques, irrigation and implementing plans necessary for agricultural development. The Food and Agriculture Organization (FAO) sent its team during this time. After the beginning of the democratic political system in 1951, the first United States Agency for International Development (USAID) subsequently began its assistance programme. Thus, in 1952, a new agricultural plan was developed with a aim of providing information on improved seeds, chemical fertilizer and improved agricultural tools (Dahal, 1997). Until the mid-20th century, there was a gradual decrease in agricultural inputs and almost collapse of agricultural system. The root causes of the problem were identified as growing population pressure, ecological imbalance, declining productive capacity of soil and increasing pressure on land. Realizing this critical situation, the first conference on agriculture was held on 2nd November 1958 (Dahal, 1997). The focus of the conference was on agricultural development programme, plans and challenges in the development. This was a systematic initiation towards agricultural development in Nepal. Agriculture was the main agenda for the poverty reduction in the Fifth and Sixth Five Year Plan (1974-1985).

AGRICULTURAL INTENSIFICATION AND IMPROVED LIVELIHOOD

In Nepal, the average land holdings decreased by 0.17 ha; from 0.96 ha in 1991/1992 to 0.79 ha in 2001/2002 (CBS, 2002). Such trend has seriously threatened the livelihood and food security of those who depend on agriculture (Thapa and Niroula, 2008). The situation is even worse in mid-hills where landholdings of farmers are small and the opportunities for them to have other sources of income from non-agricultural activities are also limited. Therefore, vast majority of Nepalese hill farmers have chosen land intensification as an alternative approach for livelihood.

ECONOMIC INDICATOR

Several studies done in mid-hills show that economy of the farmers involved in agricultural intensification, has been reported to be improved (Katwal and Sah, 1992; Brown and Kennedy, 2005 and Dahal et al, 2007). For example, in Khani Khola area of Dhading district, farmers have intensified the land by vegetable cultivation. This has contributed to tripling household incomes over the last 15 years (Katwal and Sah, 1992). The yield has increased in both cereal-based and vegetable-based cropping patterns by 41% and 61% respectively. The net income from the vegetable production is found to be significantly high as compared to cereal crop production (Tiwari et al., 2008). Similarly, in Phewatal watershed, an increase in cash crop production has resulted in a tripling of household incomes (Dahal et al., 2007 and Poudel, 2002). There are several factors that bring relatively higher income from intensified agriculture. These factors are intensive care of plots by farmers during leisure time, use of high yielding varieties, high inputs of chemical fertilizers compared with traditional cultivation system, high labor inputs and high market prices of the crop they have chosen.

SOCIAL INDICATOR

Food security is important social determinant of the livelihood. The shift from subsistence cereal farming to an intensive vegetable-based farming system has significantly improved the food security mainly among the poor and disadvantaged groups in mid-hills of Nepal. The vegetables growers have increased their income from farm by selling vegetables in nearby markets and thus, from the income, they can buy food and other household items from the same market. It is reported that only half of the farmers relying on cereal-based cropping pattern could meet food requirement for only half the year. But after intensive vegetable farming, over half of the famers have increased their household income to avoid food shortage (Tiwari et al., 2008). Thus, agricultural intensification enhanced the quantity of food produced, improvements in food security (Katwal and Sah, 1992; Carswell, 1997; Dahal et al., 2007 and Tiwari et al., 2008;) and farmers are also able to consume more nutritious food in terms of more green vegetables in their diet (Tiwari et al., 2008).

Agricultural intensification has increased ***employment opportunities*** for local people in mid- hills. It opens new opportunity of employment in the markets of agricultural products, fertilizers and pesticides. Farmers with large landholdings hire local farmers who have small landholdings, for cultivation and transport of farm production up to the market (Tiwari et al., 2008). Furthermore, labor wages has also been increased which benefited the poor and disadvantaged groups.

The ***decision-making processes*** at household level have been changed after the intensification process has been introduced (Rasul and Thapa, 2003). The autonomous decision making process led by household head has been changed to consensus-based decision making process together with all family members. The decision making particularly in selection of crop varieties, adoption of new technologies and marketing of farm produces has changed (Tiwari et al., 2008).

There is the clear ***division of labor*** and responsibilities among the family members in Nepal. Male members mostly involve in plough, digging, threshing and marketing. Female members involve in planting, farm yard manure application and harvesting of crops. The shift from cereal-based production to vegetable production system has changed the social values at local level and somehow got rid of the existing division of labor between male and female and among different caste systems (Tiwari et al., 2008). Both male and female are engaged in land preparation, planting, fertilizer buying and application and harvesting the crops. Both of them are involved in selling their farm produce in the market and buying household consumption materials and vegetable inputs. Such marketing activities help them in providing access to price information, opportunity to expose themselves to other communities and interact with them, increase bargaining power of their farm products and make them able to compete in the market. Also the caste-based division of labor has been changed to some extent. Before, the so called higher caste people *(Brahmin and Chhetri)* did not plough the land and used to hire the lower caste people. But because of adoption of agricultural intensification, lower caste people started cultivating vegetables in their own farm land by observing higher caste people getting benefit from it (Tiwari et al., 2008). As lower caste people get busy on their own farm, there is the situation of labor shortage for higher caste people, thus giving them relatively lower returns than before. In this way, the shift from traditional agricultural system to more intensive agriculture system has changed labor division to some extent.

INSTITUTIONAL INDICATOR

Institutional indicators like ***local institutions*** and ***leadership*** are the indicators for livelihood improvement. Community-based local institutions (the self-initiated local level institutions) in the region includes Conservation and Development Groups (CDGs), Community Forest User Groups (FUGs) and Women Groups (WGs). CDGs focus on integrated farmland and resource management in which all member households participate in a regular meeting regarding experiences about the farming. Such social capitals encourage

local farmers, women and disadvantaged groups to participate in decision making process, for leadership development, social mobilization and encourage them for saving and credit programs (Preety, 1995 and Tiwari et al., 2008). Some of the Users' Groups have leaders from the minority groups and women which show that the discrimination based on caste and gender has been decreasing with the adoption of agricultural intensification.

OTHER FACE OF AGRICULTURAL INTENSIFICATION: SOIL DEGRADATION AND GREENHOUSE GAS EMISSION

As an outcome of globalization and modernization, farmers in mid-hills started adopting new farming technology and modern inputs which were almost unknown to most of the illiterate farmers before. They adopted by seeing others doing it. Further, inadequate training and lack of effective regulations regarding subsidy policies made the modern inputs cheaper leading to an excessive use of it. This has led to negative environmental impacts. The country's average crops per annum have increased from 1.6 in 1986 to 2.7 for irrigated agriculture and to 2.5 for rain-fed agriculture in mid 1990s (Westarp et al., 2004) because of which an excessive and inappropriate use of chemical fertilizers and pesticides with an aim of increasing production has almost overlooked essential *environment* factor.

SOIL DEGRADATION

Soil degradation implies decline in soil quality due to anthropogenic activities. It has mainly three principal processes: physical process includes crusting, compaction and erosion; chemical process includes nutrient depletion, leaching, acidification and salinization; and biological process includes depletion of soil organic matter and reduction in soil biodiversity. Agricultural intensification raises concerns about soil erosion, nutrient depletion, water quality and soil organic matter depletion (Gardner and Gerrard 2003; Shrestha et al., 2004 and Westarp et al., 2004). These concerns are particularly relevant in the mid-hill regions of Nepal where the region has been intensively cultivated and the majority of the population is dependent upon land to accomplish their basic needs. Soil erosion is a serious problem in the mid-hills (Sitaula et al., 2000).

The issue of accelerated erosion was developed from a number of studies and impressionistic writings, which claimed that Nepal would slide away into Ganges by the year 2000 and that the Nepalese hill farmer was to blame for this situation (Biot et al., 1995: 96).

Soil loss through surface erosion from the agricultural land in hills varies from less than 2 tons $ha^{-1}year^{-1}$ to highest soil loss of 105 tons $ha^{-1}year^{-1}$ (Acharya et al., 2007). Soil losses are found to be higher in Bari[1] land on sloping terraces (32 tons/ha/year) than in Khet[2] land (less than 1 ton/ha/year) which is directly related to slope gradient and it is cheaper to make sloping terraces than making level terraces (Shrestha et al., 2004). Thus, the frequent breaking and loosening of soil through regular hoeing and plough had forced soil to erosion. Soil degradation through nutrient depletion is also a serious issue (Lal, 2000) Many studies have shown that soils in mid-hills have very low nutrients especially nitrogen and phosphorous (Shah and Schreier, 1991; and Brown 1997; and Westarp et al., 2004). In particular, the double and triple annual cropping rotations are more nutrient demanding. Thus in order to fulfill nutrient requirements, increased number of crops per annum has

[1] Rain-fed uplands with maize based cropping system
[2] Irrigated lowlands with rice based cropping system

increased the inputs of chemical fertilizers in their farm. As a consequence of increased fertilizer use during intensification process, soils in mid-hills are becoming more acidic (Westarp et al., 2004).

The intensification also leads to the deterioration of nearby water bodies like rivers. During the monsoon time, heavy rainfall takes away tons of soil with nutrients from hills to the water bodies. It has been found that water bodies near to the intensification area have higher concentration of nitrogen, phosphorous and potassium. This is due to higher amount of chemical fertilizer use for intensive production of crops and the nutrients have been washed down (Dahal et al., 2007).

GREENHOUSE GAS EMISSION

Methane (CH_4) and nitrous oxide (N_2O) are the most significant greenhouse gases that are emitted from the agriculture practices. Agricultural intensification contributes directly to emissions through variety of processes. But, the paper will focus on emissions from crop intensification looking into the levels of chemical fertilizer inputs, tillage frequency, number of crops per year and types of cultivation. Most of the N_2O from soils is produced mainly by two biological processes, namely nitrification and denitrification. N_2O evolved from soils either by oxidation of ammonium to nitrate by nitrifying microorganisms under aerobic condition or by reduction of nitrate by denitrifying microorganisms under anaerobic conditions (Bremner, 1997). The process is accelerated when soils are treated with ammonium or ammonium yielding chemical fertilizers. Similarly, net CH_4 production has been found to be increasing in the high-input cropping system due to increased soil respiration resulting in anaerobic conditions. Methane oxidation was lower in fertilized than in unfertilized soil as there was an excess of NH_4^+ concentration in the fertilized soil. Frequent tillage in soil, exposes soil surface and releases carbon dioxide that is presented as sequestered in soil particles.

Many studies have been done on linking agricultural intensification and greenhouse gas emission in different countries (Ojima et al., 1993; Pathak, 1999; Sitaula et al., 2000; and Werner et al., 2004) which shows that the intensification process led to the emission of climate gases. Only few studies have been done in Nepal. It has been found that land-use changes in mid-hills from forest or grassland to flooded rice fields were and are still significant sources for CH4 release into the atmosphere (Awasthi, 2004). Referring to the previous established research, it can be said that intensified cropping system in the mid-hills will probably have tremendous greenhouse gas emissions.

CHANGING CLIMATE AND NEPALESE AGRICULTURE

There are some evidences that the climate has been changing in Nepal. The temperature has been increased by 1.8^oC during last 32 years and the average temperature increase was recorded as 0.06^oC per year. The rainfall pattern is also experienced as inconsistent with higher intensities of rain and less number of rainy days (Malla, 2008). The emission of methane from rice field supplied with 50% nitrogen fertilizer was 49 kg per hectare which is quite high without irrigation facilities (Malla, 2006). The plains (Terai) of Nepal faced a problem of rain deficit during 2005 and 2006 due to early monsoon which reduced the crop production by 12.5% on national basis. Around 10% of the country's arable land was left fallow due to rain deficit where as there was flood in mid western Terai, that decreased production by 30% in the same year (Malla, 2008). Early maturity of the crops due to increasing temperature helps to increase the number of crops per year. But increasing number of crops lead to increase in agricultural activities like tilling and agro-inputs. This has potential implication on soil degradation and emission of greenhouse gases in the fragile landscape of mid-hill region.

ESTABLISHING THE POTENTIAL LINKAGES OF AGRICULTURAL INTENSIFICATION TO THE DEGRADATION AND MARGINALIZATION THESIS

By now, the positive and negative effects of agricultural intensification have been identified. It is also discussed on how farmers perceive intensification despite their knowing and unknowingness about environmental degradation that it causes. To be unbiased, livelihood of people comes first. Unless a farmer could feed his family, how could he think of other factors? I strongly agree on it. But the potential risk in a long run which is very contextual is also a serious issue. The cost of potential damage caused by environmental degradation might exceed the cost of livelihood improvement. The potential effects will then have profound influence on who gets to eat and who does not, who is forced to migrate and who is not, and who controls the labor of others and who does not. With this background I would like to put forward the main thesis: *"Otherwise environmentally innocuous local production systems undergo transition to overexploitation of natural resources on which they depend as a response to state development intervention and/or increasing integration in regional and global markets"* (Robbins, 2004:131).

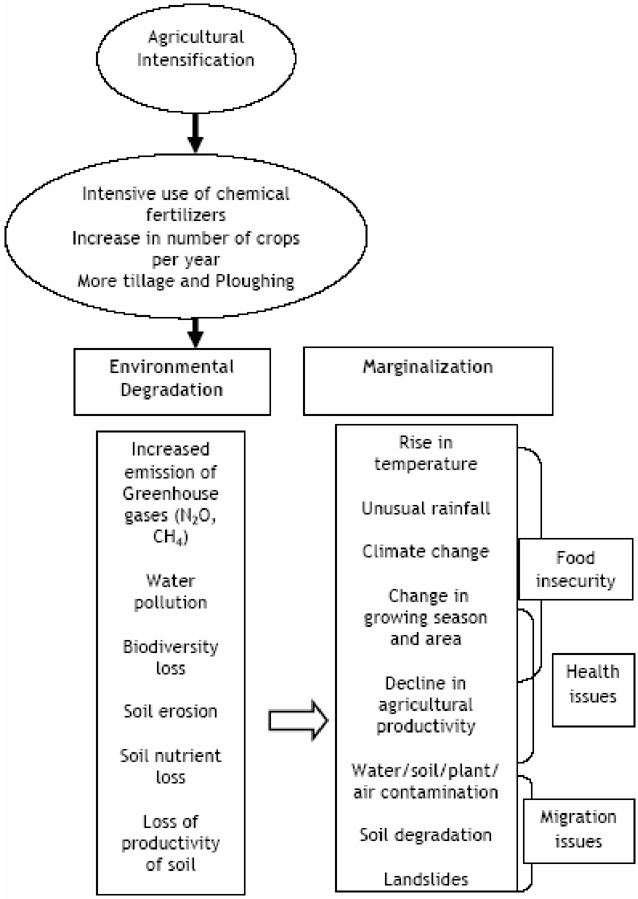


Fig. 1: Establishing the linkages between agricultural intensification potentially leading to marginalization

The process of marginalization due to intensification might be local. There are many factors like topography, socioeconomic condition, institution that play a great role in differing the process of marginalization due to intensification. There are different potential pathways for marginalization that are traced within the framework of the concept of this paper. Fig.1 shows the linkages which are discussed below.

FOOD INSECURITY

It is primarily through changes in temperature, rainfall pattern, growing season that will affect agriculture. A big concern for developing countries due to changing climate is the possibility of decrease in the agricultural productivity, which may create a scenario of food insecurity. The changing climate may not be favourable for some of the varieties of crops. Specific impacts, possibly, will be complex; however, most researches concluded that fauna and flora are very vulnerable to small changes in climate (Gisladottir and Stocking, 2005). For example, in middle and higher latitudes, global warming tend to extend the length of potential growing season, earlier planting, maturation and harvesting and the possibility of two or more crops within the same season. But then more crops require more tilling of fragile land in mid-hills which eventually leads to soil degradation. Also the addition of chemical fertilizers leads to the emission of greenhouse gases which again affect the unusual weather pattern. In lower and warmer latitude regions, the increased temperature accelerates the rate of plant respiration that provides less than optimal condition for net growth, thus crops respond negatively with decline in growth and yield (Rosenzweig and Hillel, 1995). Also, the warmer temperature is favourable for the invasion of different pests that are agents of livestock disease. This in turn cuts the food supply of meat and dairy products.

HEALTH ISSUES

Agricultural intensification process produces food in larger quantities with different level of diversity. Such situation increases food availability at lower prices for the farmers and leading to access to food. Thus, on a positive side, agricultural intensification potentially reduces the food borne illness whereas on the other side, the productivity might decline due to unusual temperature and rainfall pattern. The situation might be much worse in mid-hills where the soil is very fragile. Soil, air, water bodies and even plants are contaminated with overuse of chemical fertilizers and pesticides through different pathways. The direct and indirect exposure to fertilizers and pesticides will have direct consequences to human health. The economic loss due to ill health of farmers is of concern. There have been many episodes of water/vector borne diseases due to irrigation canals, ditches, etc. constructed for agricultural purposes (Mutero et al., 2006).

MIGRATION ISSUES

There have been evidences of increasing soil erosion, nutrient depletion and soil acidification in the mid-hills as we have already discussed above. The soils are deficient in nitrogen, phosphorous and sulphur and other micronutrients (Blaikie and Sadeque, 2000). Thus soil fertility of the mid-hill region is not rich enough to sustain the need of increased agricultural production for the growing population. Marginal households become less able to secure the labor or capital inputs to manage changing soil conditions, thus people probably think of leaving the land and move to some other places where the land is more fertile. It will be easier for farmers to accept migration situation created by unsustainable practices more easily, in the situation where adults from mid-hills are frequently moving to other places due to different socio-political reasons (Dutt, 1981).

INSTITUTIONS AS A CATALYST

Institution refers to different policies, institutions and organizations that are involved in the process of intensification.

National Agricultural Policy- More than 80 percent of the country population is dependent on agriculture. So, the national agricultural Policy of Nepal put emphasis on agricultural production through the use of agro inputs, road networks, marketing infrastructure and rural electrification (NPC, 1995 and Dahal et al., 2007). Earlier, government provided fertilizer subsidies to encourage investments in agriculture from 1973/74 until 1996/97. This policy was brought in to serve two purposes: first, encouraging farmers to use fertilizers by providing at relatively low price, and second, discouraging outflow of fertilizers from Nepal to India. This directed the government to bear huge financial burden as subsidy allocation. Thus, the government decided to deregulate the subsidy policy

(1997/98-2007/08). Since one of the objectives of National Fertilizer Policy (NFP, 2002) is to enhance fertilizer consumption through policy and infrastructure management and deregulation policy failed to bring desirable impact on improving supply situation and quality control on fertilizer, the government has decided again to providing fertilizers at subsidized rate. One of the features of the later decision is that the fertilizers will be distributed according to the technically required amount for three crops a year. This clearly shows that National Agricultural Policy and Fertilizer Policy have emphasized on intensification process (policy paper by MoAC, 2009).

Government institutions- There are different field level government institutions like Agricultural and Livestock Extension offices. But these offices do not seem very effective. Some of the extension models tried so far includes: (i) the traditional approach in which JTA[1] is expected to provide assistance to anybody for any problem; (ii) the training and visit approach applied mostly in Terai; (iii) the tuki (a Nepali term used for kerosene lamp) approach in which JTA acted both as a source of information and a commission agent for purchased inputs he/she supplied; (iv) farming system approach, further concentrating on service delivery in selected sites of having higher potentials; (v) the group approach in which farmers' groups are constituted according to the main commodity they grow like rice group, vegetable group etc (Blaikie and Sadeque, 2000). The extension offices are supposed to educate local farmers about new varieties of crops and vegetables, to monitor and control the quality of improved seed, fertilizers and pesticide use. Integrated pest management (IPM[4]) technology has already been launched in view of controlling the pest. However, implementation of such mechanisms might not be strong.

Market mechanisms- Agricultural marketing comprises buying, selling, storage, processing, standardization, certification and distribution of farm products. The process of transfer from farmers to consumers has to pass through a channel including changes in their forms and prices (Pokhrel and Thapa, 2007). The farm produces are taken to the nearby markets through middleman who decides prices of farm produce. The prices are based on the previous day's wholesale market price and also include transport cost, tax, quality of products and profit margin. Most of the local farmers are unaware of market prices. Thus, the middleman gets benefit than the local farmers while selling the farm produce. Agricultural policymakers in many developing countries perceive them as parasites who take away a large share of the benefit from crop selling (Ellis, 1996; Pokhrel and Thapa, 2007 and Tiwari et al., 2008). The traders and middlemen are cheating farmers taking advantage of their lack of knowledge of market prices and poor bargaining power arising from illiteracy and low social status which further weakens when combined with seasonal shortfalls of cash, and lack of storage facilities (Thapa et al., 1995; Banskota and Sharma, 1999; and Shrestha and Shrestha, 2000). In addition, middleman provides agricultural inputs and other household goods on loan to the local farmers. Such situations have obliged them to sell their products to the same middleman so that they repay their credit. As the farmers are able to get chemical fertilizers on loan, they will not have control on using the fertilizers. In addition, they always want to get cash out of their farm produces without taking risk of its storage. Thus it can be said that the worse market mechanism is pushing farmers to practice for intensified farming.

FARMERS' PERCEPTION ON AGRICULTURAL INTENSIFICATION

Agricultural intensification has serious implication on environmental degradation. But how farmers perceive intensification as a problem for environment is influenced by many factors. Farmers' personal characteristics, feelings and ambition significantly persuade on the adoption of new technologies and methods of production (Poudel and Thapa, 2004). The

[1] Junior Technical Assistant
[4] Integrated Pest Management

productivity depends on what technologies are applied and which cropping method is practiced. Thus, the degree of intensification depends on the peoples' choice on techniques of doing agriculture.

Those farmers who are illiterate and have less exposure to society and institutions may not easily consider management practices compared with literate farmers (Mehta and Killert, 1998 and Rauniyar, 1998). The consideration of environmental degradation by farmers also depends on the farmers' household size, income source and also on social background like rich, poor and the caste they belong to. If the major income source is based on agriculture, then they may not prefer to consider environmental degradation due to intensification. People whose main income source is not agriculture are less concerned about land conservation issues compared to those whose livelihood primarily based on agriculture (Poudel and Thapa, 2004).

TOWARDS SUSTAINABLE AGRICULTURAL INTENSIFICATION

The concern of feeding a fertile population from infertile soil in fragile and marginal agricultural land in mid-hills is really a dilemma. The situation of food security and socioeconomic condition could become worse unless the agricultural productivity and rural economies get better. The intensification process can be adopted but with appropriate technologies and in ecologically friendly way. Thus a path towards sustainable intensification would be an option. Then the question comes how to achieve it? As soil is the primary thing for enhanced agricultural production, approaches towards integrated nutrient and pest management have already been launched. The misconception on farmers about high doses of chemical fertilizer inputs increase the productivity can be somehow made clear through improvements in IPM and farmers' field schools. Policies can be made to enforce environmental taxes on nitrogen fertilizers, promote better timing of fertilizer and manure application. Sustainable agricultural intensification could be achieved through adoption of high yielding varieties, terracing, legume intercropping, contour hedgerows, cover crops, minimum tillage, selection of appropriate crops, organic and inorganic fertilizer use etc. On top of that good institutional system plays a great role to guide the sustainable agricultural practices. The creation of local institutions that increase the market strength of small farmers and the presence of state policies that support powerless to compete, will lead sustainable agriculture economically feasible.

CONCLUSION

Agriculture being the main occupation of Nepal, the developmental plans has focused on increasing the agricultural production in order to meet food demand of the growing population. Farmers in the mid-hills are widely practicing the intensification through intensive use of chemical fertilizers, pesticides, introduction of agro equipments and increasing number of crops per year.

Agricultural intensification has a positive implication on livelihood security in terms of better economic condition, social conditions like food security, employment opportunity and improved division of labor; and improved institution. But on the other side, intensification has potential negative implications on soil degradation through soil erosion, nutrient depletion and soil acidification; and climate change through emission of greenhouse gases. The emissions of CH_4 and N_2O from agricultural soil are increased especially due to tillage, fertilizer inputs and irrigation, key elements of agricultural intensification. In order to have a better understanding of the implications due to agricultural intensification, more specific knowledge of the linkages between agricultural intensification, environmental degradation and its potential pathways to marginalization is established.

Indeed, the role of institutions like government institutions and market mechanisms play a vital role in implementing policies that should enable and encourage for sustainable development based on local resources and local knowledge. In order to follow a middle path to secure both livelihood and environment, an approach to sustainable agricultural intensification would be a think piece.

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KNOWLEDGE, PRACTICE AND USE OF PESTICIDES AMONG COMMERCIAL VEGETABLE GROWERS OF DHADING DISTRICT, NEPAL

P. Shrestha[1], P. Koirala[2] and A. S. Tamrakar [2]

ABSTRACT

A field study was conducted to evaluate knowledge, practice and use of pesticides among thirty commercial vegetable growers of Dhading district of Nepal. More than four in five were using pesticides and more than one third were using it for more than six years. Nearly half of them spray pesticides five to six times. More than one-sixth pesticides used were extremely hazardous, which were barred for general agriculture use. Waiting period is less than four days for nearly two-third growers. More than three-forth know the adverse effect of pesticides and nearly half experienced symptoms of health hazards. Majority did not receive any official training on pesticides and nearly one-third doesn't read information available in pesticide label. Nearly half were not using Personal Protective Equipment during pesticide application. Nearly two-third throw pesticide container anywhere after using it. The finding of this study is oriented to the following recommendation: the need for awareness, education and training on the uses of pesticides to the farmers and effective monitoring program for pesticide residues in vegetables.

Key words: Awareness, health effects, IPM, pesticides, vegetables

INTRODUCTION

Fresh vegetables are an essential part of a healthy diet as it is an important source of vitamins and minerals. However, vegetables can also be a source of poisonous toxic substance-pesticides (Knezevic Z. and Serdar M., 2008). Over 1000 compounds may be applied to agricultural crops in order to control objectionable moulds, insects and weeds (Ortelli et al., 2006). Pesticides' striking effort in preventing, crop loss and controlling vectors of diseases have led to their acceptance and expanded use throughout the world (Sharp and Peter 2005). However, the potent chemicals for killing pests have elevated anxiety that they are agents of human diseases and environmental pollution. It has been observed that their long term, low dose exposure is increasingly linked to human health effects such as immune-suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer (Wiles, Davies and Campbell, 1998). Pesticide residues in food are global problems (Abinash and Singh 2009).

Pesticides classified as being extremely or highly hazardous by FAO and WHO, including barred by some countries, unrelenting used in developing countries (WHO 2003). According to WHO, developing countries use about twenty-five percent of the pesticides in the worlds, and the use is in increasing trend. This intrinsically dangerous technology is being promoted in a setting without technical and human resources to control it properly.

Agriculture work is one of the most prevalent types of employment in the world. Nearly 50 percent of the world labor is employed in agriculture and they carry significant risk for development of pesticide risk (Das et at., 2001). Global warming will create a promising threat in pesticide safety in foods and human health (Koirala et al., 2009). The potential impact of climate change on pesticide safety is a widely debated and investigated issue (Bailey, 2008).

[1] College of Applied Food and Dairy Technology, Kathmandu Nepal
[2] Tribhuvan University, Kathmandu Nepal

Chemical pesticides for the first time were commenced in Nepal in 1952 when Paris green Gammexane and Nicotine sulphate were imported from USA solely for malaria control program- (Koirala et al., 2009). The sequential order of different groups of pesticides introduced in Nepal is: 1950s – organochlorines; 1960s – organophosphates; 1970s – carbamates; 1980s – synthetic pyrethroids. (Manandhar, 2007). Now, Nepal import pesticides from six different countries-India, China, Malaysia, Singapore, Italy and Japan (PRMD 2009). Local manufacture is in small quantities. At present, there are four industries that have been registered to manufacture and formulate pesticides. Pesticide Registration and Management Division (PRMD) under the Ministry of Agriculture and Cooperatives is responsible for registration of pesticides as well as providing license for import and distribution of pesticides to retailers and wholesalers according to Pesticide Act 1991. By the end of 2010, Fifty two certified importers are involved in marketing of seventy six registered common pesticides in three hundred and forty two trade names. Majority of registered pesticides are insecticides (36/76)- followed by fungicides (18/76) (Koirala et al., 2009).

The pesticide import data for the year 2006 is- 131285 kg (based on active ingredient) and 338365 kg based on formulation) and for the year 2007 is 347495 kg (based on a.i) and 762543 kg (based on formulation). The import data for the year 2007 is almost 250% higher compared to the year 2006 (PRMD, 2009). There is no clear drift of import and use of pesticides. Also there is possibility of an open border trading of commonly used pesticides and some of the banned pesticides such as DDT and BHC. It is somewhat difficult to document the amount of illegal trading and thus the size of such trading has not been reflected in the public data so far.

In recent years, there are different pesticides used erratically, which is pretty common in Nepal. Endosulfan is used in ponds, streams and rivers for killing fishes. This has created potential danger for extinct of the most commonly and in large quantities available native species of fishes. Similarly, endosulfan is also used to attain polished appearance in vegetables such as tomato, brinjal, mustard leaves. Blend of pesticides is also applied in different vegetables and tea. Some insecticides are also applied to fish surface to keep flies away from it during display in shop. Almunium phosphide is used for fumigation in open mud beans adjacent to bed room. Use of date expired pesticides and throwing pesticide containers at public places is a wide-ranging practice. Pesticide treated grains is given for nourishing horses (Manandhar, 2007).

Nepal has a marvelous opportunity for producing vegetables as diverse agro-eco-zone favors both season and off-season varieties. Due to this advantage farmers are encouraged to produce vegetables. Thus production and productivity of vegetables has been increasing significantly for the last decade. Nepal has sell to other countries potential for fresh vegetables and processed products in the international market as well.

Dhading district supply nearly 20 percent of total requirement of vegetables of Kathmandu Valley. Reports suggest that use of pesticides in vegetable in Nepal is higher than other food products (Koirala et al., 2009). No previous research reports are available for pesticide use in vegetables for Dhading district. Therefore, this study aims to know the current situation of pesticide use in vegetables and to investigate knowledge, practice among commercial vegetable growers and use of pesticides in vegetables of Dhading district, Nepal. Field study was made on September to October, 2009.

MATERIAL AND METHODS

Two Village Development Committee (VDCs) in Dhading district namely Jiwanpur and Kewalpur, which are the major production areas of vegetables, were chosen for the study reason. In one VDC, three wards were selected. In a single ward five households who were involved in commercial vegetable farming were selected. Altogether accounts thirty households in two VDCs. The commercial vegetable growers who were occupied in broccoli, brinjal, cauliflower, lady finger and beans growers included under this study. Field survey was made by using structured questionnaire. Data analysis was made using SPSS software.

RESULT AND DISCUSSIONS

PESTICIDES USERS AND PESTICIDES USED

A total of thirty households were surveyed during the study. Half (50%) of the vegetable grower were literate and majority of them (70%) had only primary education. Forty percent work hard daily about 5-9 hours in the vegetable field. Preponderance (86.6%) apply pesticides to vegetables. This showed that in the current year the uses of the pesticides in vegetables has increased and is in rising trend. Nearly a half (46.6%) applies pesticide 5-6 times, whereas, nearly one-forth (23.3 %) use it 3-4 times depending on severity of pest problem in vegetables. It indicates that there is a high frequency of pesticides use in the vegetable that are possibly to increase toxic residue in the vegetable that might pose higher risk to vegetable growers and consumers.

Growers spray insecticides such as Parathion-Methyl (extremely hazardous 'Ia'); Dichlorovas, Carbofuran (highly hazardous 'Ib'); Alphacypermethrin, Chlorpyrifos, Cypermethrin, Deltramethrin, Dimethoate, Endosulfan, Lambda-Cyhalothrin, Profenofos (moderately hazardous 'II'); Dimethipin (slightly hazardous 'III') and fungicides such as Carbendazim, Mancozeb, Maneb and Metalaxyl. Among the pesticides sprayed, half (50%) of it was of category II, 16.7% was of category I (Table 1). Use of extremely hazardous pesticides (category I) are banned in the country. The use of these types of high toxic pesticides put health threat for both growers and consumers.

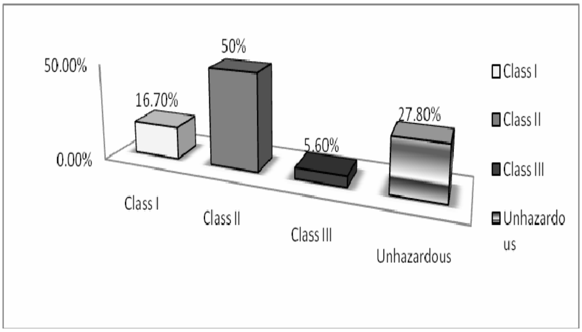

Fig. 1: Types of Pesticide Used according to the Hazardous Level of WHO

KNOWLEDGE OF PESTICIDE

Majority of growers (93.3%) did not receive training at all on the use of pesticides. Training helps to get learning on safe handling, storage, disposal and application of pesticides. Therefore, there is a call for promotion of training to growers by government or other development organizations. More than three-forth of vegetable growers (80%) have knowledge about the adverse health effects of pesticides, and nearly more than one forth (26.6 %) do not have the knowledge about the adverse effects. Almost nearly half (42.9%) heard about health hazards of pesticides. Among heard, the major source of information was community (42.9%). More than forty percent (43.3%) think that use of pesticides in future should be decreased in agriculture. Such case suggests that majority want to diminish the use of pesticide and use alternative method that are not dangerous to human and environment. Nearly one-forth (23.3%) have heard about Integrated Pest Management (IPM). Among heard, a little more than a half (53.3%) were using IPM technique. Government of Nepal is promoting IPM to reduce users' dependency on pesticides in agriculture farming. One of the objectives of IPM use is to promote food safety. This study also suggests that the government should promote IPM program for healthier agriculture practices because more than a half of growers now already using IPM technique.

Table 1: Types of pesticide used

S.N	Trade Name	Common Name	Phy. State	Chem. Type	Main Use	Classification
1.	Farsa	Alphacypermethrin 10% EC	S	PV	Insecticides	class ii
2.	Aerosol	Carbendazim 50% W.P	S		Fungicides	unhazardous
3.	Furan 3G	Carbofuran 3% g	S	C	Insecticides	class ib
4.	Durban	Chlorpyrifos 20% EC	S	OP	Insecticides	class ii
5.	a.Surya Methrin-10 b. Bicep	Cypermethrin 10% EC	L	PV	Insecticides	class ii
6.	Super-D	Cypermethrin 5%+ Chloropyriphas 50%	L S	PY+OP	Insecticides	class ii
7.	Desist	Deltramethrin	S	PY	Insecticides	class ii
8.	a. Bloom b. Nuwan	Dichorovas 76% EC	L	OP	Insecticides	class ib
9.	a. Rogor b. Rogorin	Dimethipin 30% EC	I		Herbicides	class iii
10.	Rogoris	Dimethoate30% EC	S	OP	Insecticides	classii
11.	a.Thiodan b. R-Sulfa	Endosulfan 35% EC	S	OC	Insecticides	class ii
12.	Propel	Lambda-Cyhalothrin 2.5% EC	S	PY	Insecticides	class ii
13.	a. Surya M-45 b. Uthane M-45	Mancozeb 75%W.P	S	FC	Fungicides	unhazardous
14.	Manex	Maneb	S	C	Fungicides	unhazardous
15.	a. Targmil b. Kriiaxyl Mz 72%WP	Metalaxyl 8%+ Mancozeb0.4% wp Metalaxyl 8%+ Mancozeb 64% W.P	SS SS	FC	Fungicides	unhazardous
16.	Devithion[Th]50	Methyl Parathion 50% EC	L	OP	Insecticides	class ia
17.	Antirot	Mono-p% Potassium Phosphite	S	FC	Fungicides	unhazardous
18.	Current	Profenofos 50% EC	L	OP	Insecticides	class ii

PRACTICE OF PESTICIDE HANDLING

Pesticides label hold different information related to safety measures to be taken while using. About one-third (33.3%) read label information, however, only one-fifth (16.6%) follow the advice provided in the label.

Almost half of the vegetable growers mix the pesticides with their bare hands and only about one-sixth (16.6%) mix in a safer way by wearing gloves. Many pesticides users are highly exposed to dermal exposure due to unsafe mixing practice resulting acute and chronic health hazards. Similarly, there is a need of determination of wind before the application of pesticides. Nearly three fourth of the vegetable growers (76.6%) determine the wind direction before spraying while the rest (23.4%) do not. Majority of the pesticide users (76.6%) re-enter the field within short interval 0-4 days after the application of the pesticide, whereas, 24.2 percent of the vegetable grower re-enter at an interval of 5-9 days. Entrance results a greater risk of inhalation, dermal exposure, eye exposure and cause significant health hazards due to exposure of pesticide. Toxic pesticides residue remains in the field after the application of pesticide.

Waiting period is the duration after which the vegetables treated with pesticides can be used. Almost more than a half (53.3%) of vegetable growers picks the vegetable at the interval of 0-4 days after the application of pesticides. Less waiting period indicates that there is a higher risk of presence of pesticides residue in vegetables which poses higher health risk to vegetable growers as well as consumers.

Practice of maintaining personal hygiene decreases risk of health hazards. Majority of the pesticides sprayers (84.8%) do not drink and smoke during pesticide application. Most of the respondents (93.3%) maintain personal hygiene after pesticide spray. Among them, one-fifth (20 %) take bath which is a good practice and rest (80%) maintain by cleaning hands and feet. Nearly forty percent (36.6%) pesticide users have experienced the symptoms of health hazards. The major problems were eye and skin irritation (46.6%) followed by (33.3%) multiple symptoms such as shortness to breath (16.6%) and headache (10%). It suggests that pesticide related health problems are common among vegetable growers.

Personal protective equipments include clothes and devices that protect the body from the contact with pesticide during pesticide application. Most of the pesticide users (66.6%) didn't use PPE. The reason for not using PPE was lack of knowledge. They don't have affordability and the habit of wearing. Due to unsafe practices, vegetable growers are more vulnerable to expose with toxic pesticides and are in higher health risks as there has been too much use of pesticides with too little or no protection.

PESTICIDES STORAGE, DISPOSAL OF EMPTY CONTAINERS AND WASHING OF APPLICATOR

Pesticides should be stored in the separate area far away from food, feed, children and pets. Majority of users (86.6%) store it in a separate place away from food items and medicine. As a result there is less chance of mixing with food and feed. Children or pets also cannot search out it. Pesticides bare containers should be disposed correctly to minimize exposure of it to the environment and human. On the other hand, most of the vegetable growers (63.3%) throw the pesticide anywhere they like. They do not dispose properly.

Pesticide applicators should be washed after using it. It should be washed far away from the source of water as it may contaminate the source of water and therefore, destroying aquatic life and wildlife. More than a half of the vegetable growers (53.3%) wash pesticide applicator in the source of water like river, streams. One-fifth (20%) wash in the tap, and nearly one-forth (26.6%) wash away from the source of water. As majority of the vegetable grower wash pesticide applicator in the tap, which is the source of potable water to their home.

CONCLUSION AND RECOMMENDATIONS

The present study shows extremely hazardous pesticides are being used in vegetables which are banned for normal agriculture use by Government of Nepal. Majority growers did not receive any training on pesticides and IPM techniques. Quite a high figure of growers also experience symptoms associated with pesticides hazards. Most of the growers were not using PPE during pesticide application in vegetables. The results emphasize the need to correct the problems of pesticides. Government regulatory agencies, development organizations, consumers associations should work successfully together work out the problems.

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SELENIUM: ITS ROLE IN LIVESTOCK HEALTH AND PRODUCTIVITY

Doj Raj Khanal, PhD[1] and Anthony P. Knight DACVIM, MS[2]

ABSTRACT

Selenium (Se) is an essential metalloid trace element that has a very narrow margin of safety between the toxic and deficient doses in animals and humans. This paper highlights about the beneficial and harmful effects of Se in livestock productivity and health besides presenting some information on its relation to Khari disease of buffaloes in Baitadi and Darchula districts and ways to mitigate toxic effects of Se in buffaloes.

Key words: Selenium, deficiency, toxicity, Khari disease

HISTORICAL BACKGROUND

Selenium (Se) is a naturally occurring metalloid element that is essential to human and animal health in trace amounts but is harmful in excess. Selenium was first identified in 1817 by the Swedish chemist, Jons Jakob Berzelius; however, selenium toxicity problems in livestock had been recorded for hundreds of years previously although the cause was unknown. Marco Polo reported a hoof disease in horses during his travels in China in the 13th century. Similar problems were noted in livestock in Colombia in 1560 and in South Dakota (USA) in the mid-19th century where the syndrome was called alkali disease (Fordyce, 2005). While Jons Jakob Berzelius was isolating selenium from red deposits in the lead chambers of a sulfuric acid plant, illness of the workers in the plant was attributed to exposure to high levels of selenium (Oldfield, 1999).

Selenium has chemical and physical properties intermediate between metals and non metals and is similar to those of sulfur, arsenic and tellurium, all of which are in Group VI of the periodic chart of the elements. Like sulfur, selenium can exist in the 2^-, 0, 4^+, and 6^+ oxidation states as selenide (Se^{2-}), selenium (Se^0), selenite (Se^{4+}) and selenate (Se^{6+}), respectively. Selenium behaves antagonistically with copper and sulfur in humans and animals inhibiting the uptake and function of these elements. The volatilization of Se from volcanoes, soil, sediments, the oceans, microorganisms, plants, animals and industrial activity all contribute to the Se content of the atmosphere. Selenium is a bioaccumulator which means that plants and animals retain the element in greater concentrations than are present in the environment and the element can be bioconcentrated by 200-6000 times. Arid environments with alkaline soils, in times of drought or where less irrigation water is predispose to high soil selenium levels and a greater uptake of Se by plants. Such conditions exist in Rajasthan and southern parts of the Haryana states of India where above normal soil selenium levels (Yadav *et al.*, 2005). In parts of China the Se content of early Cambrian aged rock range from 10-40ppm (mg/kg) (Kunli et al., 2004).

The selenium status of human populations, animals, and plants varies markedly around the world as a result of different geological conditions. High selenium concentrations are associated with some phosphatic rocks, organic rich black shales, coals, and sulfide mineralization, whereas most other rock types contain very low concentrations. Globally selenium deficient soils are far more widespread than are seleniferous ones. Animal health is affected by selenium deficiency or excess in the diet, the intake of selenium being dependent on the amount of selenium taken up by plants as bioavailable selenium (Fordyce, 2005).

[1] Animal Health Research Division, PO Box 3733, Kathmandu, Nepal
[2] Department of Clinical Sciences, Colorado State University, Colorado 80523, USA

Selenium forms a vital constituent of the biologically important enzyme glutathione peroxidase (GSH-Px). This enzyme reduces peroxides in cells thus preventing oxidative injury to cells (Rotruck *et al.*, 1973). Because of this vital role, deficiency of selenium in animals may result in a wide variety of clinical signs. Selenium in the form of selenoproteins is critical in the formation of thyroid hormones and other endocrine systems. Adequate selenium levels have also been shown to be necessary for normal spermatogenesis (Kohrle *et al.*, 2005). In severe deficiency states, myodegeneration occurs resulting in cardiomyopathy, muscle weakness and death (Koller, 1986). This paper gives an overview of selenium related health disorders in livestock, precautions to be taken when submitting biological samples for diagnosis and ways to mitigate the problems associated with either selenium deficiency or toxicity.

SELENIUM TOXICITY IN ANIMALS

The toxic effects of selenium were first discovered in the 1930s when livestock ate certain plants of some wild vetches of the genus *Astragalus*, which accumulated toxic amounts of selenium from the soil (Moxon, 1937). The identification of selenium accumulator plant species (some *Astragalus species)* in the environment is an indication that grasses and other forages will also have accumulated selenium, and therefore is a risk to livestock grazing them. Soil and herbage levels of Se exceed 5 mg/kg and 3 mg/kg dry matter respectively in 90% of toxic fields (Roger *et al.*, 1990). Addition of too much selenium to feeds, improper uses of selenium containing injectable or feeding livestock forages or feed grown in soils rich in selenium can result in selenium poisoning (Hatch, 1982).

Tiwari *et al.* (2006) compared the acute toxicosis caused by organic selenium (selenomethionine) found in plants with that caused by the supplemental, inorganic form of selenium (sodium selenite) and reported that in an acute oral exposure, selenium from selenomethionine is twice as bioavailable, but can be slightly less toxic than sodium selenite. They also found that sodium selenite, but not selenomethionine administration resulted in decreased liver vitamin E concentration. Lambs receiving 2, 3, and 4 mg/kg body weight as sodium selenite and 4, 6, and 8 mg/kg body weight as selenium methionine had visible evidence of reduced feed intake, depression, reluctance to move, and tachypnea following minimal exercise. Major histopathological findings in animals of the high dose groups included multifocal myocardial necrosis and pulmonary alveolar vasculitis with pulmonary edema and hemorrhage. Some investigators (Casteignau *et al.*, 2006) reported on selenium toxicosis due to errors in dosage of selenium in swine feed that resulted in an initial episode of diarrhea followed by dermatological and neurological signs; the most obvious sign being marked hind limb paresis. Cutaneous lesions consisted of diffuse alopecia, multifocal skin necrosis and coronary band necrosis of the hooves. Central nervous system lesions comprised of a severe bilateral polio-encephalomalacia of the ventral horns. In general therefore, elemental Se is relatively non toxic whereas organic Se found in plants and grains is more toxic to livestock.

Several hundred deaths have been reported in sheep from acute/subacute selenium intoxication following grazing of seleniferous plants growing on reclaimed phosphate mines in southeastern Idaho (Fessler *et al.*, 2003). Natural selenium toxicosis was reported from seven states of the USA. Over supplementation with selenium was reported as a cause of toxicosis in 15 states (Edmondson, *et al.*, 1993). Chronic selenosis is often reported in India in winter season with the symptoms of hair loss, cracks on skin, hooves and horns, leading to elongation and sloughing of hooves, lameness, ataxia and recumbency (Gupta *et al.*, 1982). In an experimental study with buffalo calves, adverse effects appeared when the whole blood selenium concentrations increased above 2 μg/ml, with mortality occurring when blood levels exceeded 3.4 μg/ml (Deore *et al.*, 2005).

Circumstances in which selenium poisoning occur are quite variable. The Se levels of dairy cows are highest in the winter when indoor feeding of Se-rich concentrates is practiced in Norway (Ropstad *et al.*, 1988). Sugarcane foliage from seleniferous areas can accumulate high levels of selenium ranging from 7.9 to 67.5 mg/kg. These selenium levels were 6-14 times higher than those from non-seleniferous areas (Dhillon and Dillon, 1991). Researchers from India (Ghosh *et al.,* 1993) reported Selenium toxicities in grazing buffaloes of the sub-Himalayan areas of West Bengal showing gangrenous syndrome of the extremities, skin cracks or sloughing, detachment of hooves, emaciation and eventually recumbency and death.

Selenium poisoning should be generally suspected based upon a variety clinical signs including weight loss, poor growth rates, lameness, defective hoof growth, horizontal ridges or cracks in the hoof wall, hair loss, infertility and acute deaths especially when errors are made in mixing of selenium into animal feeds or overdosing injectable selenium products. A garlicky odor on the animals' breath may be detected.

Hematological changes in selenosis cases may include decreased fibrinogen levels and prothrombin activity, increased serum alkaline phosphatase, alanine aminotransferase (ALT), aspartate aminotranferase (AST), and succinic dehydrogenase and reduced glutathione levels. Serum or liver Se levels exceeding 2ppm is indicative of acute toxicity. In chronic cases hair analysis with >5 ppm selenium is confirmatory. Forage analysis in which the Se levels exceed 5ppm should be considered hazardous to livestock health. Selenium accumulator plants may contain as much as 15,000ppm of Se. Livestock grazing plants growing in soils containing in excess of 0.5ppm are at risk of developing selenosis (Rosenfeld, 1964). The Environmental Protection Agency (EPA) has set a chronic eco-toxicity threshold of 5 µg/L in water.

SELENIUM DEFICIENCY IN LIVESTOCK

Only after identifying the beneficial role of Se and vitamin E in preventing dietary hepatic necrosis and exudative diathesis in rats and chicks, was selenium's nutritional value recognized in 1957 (Mayland, 1994). Selenium is necessary for growth and fertility in animals, neutrophil and lymphocyte function, and antibody production. Clinical signs of Se deficiency include dietary hepatic apoptosis in rats and pigs; exudative diathesis, embryonic mortality, poor response to antigens, pancreatic fibrosis in birds and white muscle disease (nutritional muscular dystrophy) in ruminants and other species (Ammerman, 1975; Swecker, 1997). Clinical signs of selenium deficiencies in animals, birds and humans include reduced appetite, growth, production, and reproductive fertility, a general unthriftiness, and muscular weakness. Retained placenta is reported in selenium deficient cows, while 'mulberry heart' disease is noted in pigs. Selenium deficiency in animals is very common and widespread around the globe affecting much of South America, North America, Africa, Europe, Asia, Australia, and New Zealand (Fordyce, 2005). Survey of state veterinarians and state veterinary diagnostic laboratories revealed that selenium-deficiency diseases were diagnosed in 46 states and were reported to be an important livestock problem in regions of 37 states of the USA (Edmondson, *et al.*, 1993).

LABORATORY ANALYSIS OF SELENIUM

There have been few publications addressing the need of proper storage of samples intended for determination of selenium level (Olivas *et al.,* 1998 and Palacios and Lobinski, 2007). Organic selenium reportedly declined drastically in a matter of a month when stored at different temperatures and in different containers. Palacios and Lobinski (2007) reported that 75% of selenium was lost after 30 days of storage. Their results demonstrated the oxidative degradation of selenoproteins and glutathione peroxidase (GSHPx) during storage of serum. In the author's experience, hay samples containing relatively high levels of Se and stored at room temperature with exposure to light, when tested 6 months later had no detectable toxic levels of Se (Khanal *et al.*, 2008).

Blood and liver samples are the samples of choice for ante mortem and postmortem diagnosis of both Se deficiency and toxicity (Tiwari *et al.*, 2006). A whole blood selenium concentration is a better and more sensitive indicator of selenium status than hair selenium or glutathione peroxidase activities (Deore *et al.*, 2003). Controversy exists today as to the most suitable methods of assessing selenium levels *in vivo*. Assays of glutathione peroxidase (GSHPx) appear to be one of the promising modes of assessing Se status (Brody, 1999). Liver is the most suitable tissue for this purpose. Red blood cells (RBC) selenium levels have been used for measuring intracellular selenium levels. RBC and tissue selenium levels reflect long term selenium status, while plasma and urinary selenium levels are sensitive indicators of the amount of selenium consumed in foods the previous day or two, and do not accurately reflect tissue levels. Whole blood or serum selenium status measured at the herd level provides best consistency (Waldner *et al.*, 1998).

MITIGATION MEASURES FOR SELENIUM DEFICIENCY AND TOXICITY

The foremost approach to preventing selenium related health disorders is determining the prevalence of selenium in the environment. This may require soil and forage analysis if such information has not been determined previously. Farmers can be trained to identify Se accumulator plants so that their animals can be moved to safer areas. In Se deficient areas supplementing selenium will be necessary. In areas where Se levels are high in the soils and forages, it is necessary to avoid pastures high in Se or adopt measures to counter the toxic effect of selenium.

In general, selenium deficiencies in animals are corrected by giving injections, dietary supplements, salt licks and drenches. While correcting selenium deficiencies, administration of organic selenium such as selenium methionine was found to result in higher tissue, serum, and whole blood selenium concentrations than by the administration of equivalent doses of selenite (Tiwari *et al.*, 2006). The level of dietary selenium needed to prevent deficiency depends on the vitamin E status and species of the host. Assuming normal vitamin E status of the animal, concentrations of 0.04 - 0.1 mg/kg (dry weight) of selenium in feedstuffs are generally adequate for most animals with a range of 0.15-0.20 mg/kg for poultry and 0.03-0.05 mg/k for ruminants and pigs (WHO, 1987). International standards for Se requirements for cattle are in the range of 0.1 to 0.18 mg/kg dry matter. However there is considerable variation with the recommended level for cattle in different parts of the world; Ireland recommends are 0.24 -0.48 mg/kg dry matter (Rogers 1990), while in the USA the maximum allowable supplementation of Se is 0.3 mg/kg. In Finland, where soil selenium levels are very low, sodium selenate fertilizers had been used to produce crops with adequate amounts of selenium

Although there are no specific treatments to correct selenium toxicities in animals, recognition of seleniferous plants, proper land management and selective grazing may help prevent selenosis. Animals having a blood selenium level >1.5 µg/ml is indicative of impending selenium toxicosis and such animals should receive corrective measures to alleviate Se toxicity (Deore *et al.*, 2002). Administration of reduced glutathione (GSH) intravenously at 5 mg/kg of BW reportedly arrested the toxic signs, prevented mortality and lowered glutathione peroxidase (GSH-Px) activity (Deore *et al.*, 2005). Se toxicity in buffaloes was reportedly treated successfully in India by Arora et al (1975) and Arora (1985), using a daily oral dose of a trace mineral mixture consisting of five sulfates (1 kg magnesium sulfate, 166 gm ferrous sulfate, 24 gm copper sulfate, 75 gm zinc sulfate and 15 gm cobalt sulfate). A daily dose of 30 gm of this Pentasulfates per adult animal was given until recovery was noted (21-50 days). Of 517 buffaloes treated, 430 (83%) were cured in

21-50 days. Feeding high protein diets and a balanced mineral mix that contains sulfur and copper can reportedly reduce selenium toxicity (Fessler *et al.*, 2003).

It has been reported that application of gypsum up to 1 ton/hectare reduced selenium content in sugarcane tops from 15.16 to 5.08 mg/kg in a field experiment (Dhillon and Dhillon, 1991). Of late, phyto-remediation using kenaf and canola plants has been tried to clean up soil and water contaminated with selenium (Wood, 2000). By doing so, water and soil can be detoxified and canola enriched moderately with selenium levels can be fed to livestock in deficient areas.

Crisman *et al* (1994) demonstrated that horses that spent more than 50% of their time on pasture had a significantly lower ($p<0.001$) selenium concentration (0.124 ± 0.002 µg/ml) as compared to horses that spent less than 50% of time on pasture (0.144 ± 0.005 µg/ml). This finding is similar to the finding of Khari disease (chronic selenosis) in water buffaloes of western Nepal where the incidence is higher in stall fed buffaloes. Affected water buffaloes are reportedly showing improvement after being allowed to graze on pasture (Khanal, *et al.*, 2006).

CONCLUSION

The majority of livestock producing areas of the world are subject to the multifaceted effects of selenium on livestock health and disease. Selenium deficiency is more of a problem geographically than is Se toxicity due to seleniferous soils. Khari disease syndrome in lactating buffaloes of Darchula and Baitadi, in which Selenium toxicity was implicated as one of the multiple causative factors, has been showing very promising result to Pentasulfates-owing to its antagonistic effect to toxic levels of Selenium. The geochemistry of livestock-producing areas should be well understood to mitigate selenium related disorders in animals.

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ROLE OF FOOD TRADITION IN CONSERVING CROP LANDRACES ON-FARM

Deepak Kumar Rijal, PhD [1]

ABSTRACT

Local knowledge of crop diversity linked to food traditions, local practices and social norms is documented acquired through interaction with farmers and focus group discussion. Cooking quality of different rice varieties was assessed to see the effects of the environment factors. Different food dishes were assessed by trained cook, urban and rural consumers to identify dishes for market promotion. Diversified food traditions show close links to richness of crop landrace diversity. Crop landraces have substance, symbolic and sign values. Certain food dishes are used as symbolic offerings to different Gods such as lineage God, goddess and spirits of the past ancestors. Of the elaborated dishes tried, taro when prepared with legumes, mutton and fish, was preferred. Such preference was also landrace specific. 'Hattipow' for fried mutton, 'Panchamukhe' with fish and 'Ujarka' for Samosa are preferred. Culinary characters on rice landraces were unaffected by environment factors. The quality of improved variety, however decreased when grown in alien environments. The likelihood of crop landraces to be conserved increases if: a) they are competitive to other options farmers-custodian have b) farmer-custodian and consumers follow socio-cultural norms, and c) traditional dishes still remain popular. Increased demand for landraces and the promotion of landraces derived products help generate income and green jobs which are the same time offers of community incentives to conserve crop landraces on-farm.

Key words: Dishes, landraces, livelihoods, traditions, values

Considering food as a "driving force" for conserving biodiversity, Carlo Petrini (2000) stated that we cannot just be food lovers ... we must be there where it is most at risk as in the developing world (Slow Food, October 2000, BBC Online).

INTRODUCTION

Food traditions carry a variety of meanings and are potent expression of those locally adopted social norms. In a society, food is a substance that can be both a symbol and a sign[2]. The symbolic meanings of various foods are derived primarily from the roles they play in economic life. Food often symbolises visible indices of wealth, ethnicity and social well being of the people. In other word, meal structures are the reflection of the immaterial life. Food signifies social norms and values as expressed in metaphoric languages. Hence, food can also be seen as a social indicator. Douglas (1997) stated that if food is treated as a code it encodes the pattern of social relations expressed in varying degrees of hierarchy, inclusion or exclusion and transactions across social boundaries. Marcel Mauss (1967) describes food as a 'total social fact'. The ways food dishes are chosen and the special dishes used as symbolic offerings vary by ecological, social and economical variables. In totality, food traditions decode social systems. Along with economic benefits, the maintenance of crop landraces is also linked to peoples' cultural, social and ritual values. To be specific, food traditions are often connected to the cultivation of crop landraces since they co-evolved, shaping each other. It was observed that foods and food traditions have changed in response to changes in social norms and interests. The degree of change, however, depended largely on consumers' access to information that corresponds to diet in terms of preference and perceived benefits.

[1] rijal.deepak@gmail.com, +977 1 55 22 354, CADP-Nepal, Sanepa 2 Lalitpur, Nepal

[2] Symbol and sign refer here to food in their roles as elements in the cuisine (Weismantel, 1988).

Preliminary research results indicate that the likelihood of crop landraces being conserved increases when the market for their derived products are expanded through improved consumer access to information on recipes, nutritive and cultural values (Rijal, et al., 1999). In the first section of this article, are discussed links between food tradition and the conservation of crop landraces on-farm. The possible impacts of improved or elaborated dishes with regard to on-farm conservation of landraces of rice and taro in Nepal are also discussed.

DEMAND AND SUPPLY OF CROP LANDRACES

Farmers cultivate landraces that have both symbolic and social values together with economic benefits. The total costs and benefits of landraces to cultivating households are central to their conservation on-farm (Brush and Meng, 1998). Farmers maintain crop landraces if these are valued either for economic, cultural, social, or ecological reasons (e.g. Zimmer and Douches, 1991; Bellon and Taylor, 1993). In fact, reliable supply and producer-consumer linkages are realized constraints relating to the promotion of local crop based dishes. Unlike farmers, urban consumers are poorly informed on nutritive and cultural values of traditional dishes. In total, locally prepared products poorly qualify to attract new consumers especially in urban areas where they are exposed to a variety of choices for food dishes. However, it has been suggested that the demand for crop landraces and their derived products may be expanded through improved markets that promote consumers' awareness and policy support (Jarvis and Hodgkin, 1997).

Till date, 'productivity' has been the basis for selecting varieties in agricultural research. Since the promotion of modern varieties, most crop landraces have either been displaced from their natural habitats and / or grown in reduced areas. Smale (2000) reviewed rice landraces reserved in relatively small sizes, in patches or islands of farming systems (Brush, 1995:246), micro-centre of diversity (Harlan, 1992:147) and in decreased areas (Rijal, et al., 1999) particularly when modern varieties were widely adopted. Richness of diversity is maintained together with ecosystem, ethnicity and consumers' preferences. The key issue is that whether landraces thus displaced from their original habitats can be successfully grown under alien environments where farmers' options are limited. Their on-farm conservation is therefore dependent on how landraces are competitive in providing benefits, regardless of habitat types. It may be hypothesized that the elaboration of traditional dishes combined with improved access of consumers to associated information provides farmers incentives for on-farm conservation of landraces. The specific questions asked in this article include: a) How are food traditions linked to conservation of crop landraces? b) How does increased knowledge on food traditions / improved dishes help create / expand market demand? and c) Do environmental factors have any impact on eating quality of rice?, and d) how does this accrued knowledge imply to livelihoods together with on-farm conservation? To address some of these questions, a study of food traditions and research was initiated with reference to food dishes of rice and taro in Nepal.

STUDY SITES

Since food traditions vary between locations and societies, distinct natural and social aspects of the study villages are described. Food traditions discussed in this article have been collected from three contrasting villages located in High Hill, Mid Hill and Terai in Nepal.Talium village in Jumla district is located above 2240 meters. The climate is sub-alpine to temperate. The mean temperature is recorded at 12° C, and snow in winter is common. Rainfall is recorded around 850mm per year. The snow is considered as an important source of water for winter crops as well as crops to be planted during spring season. Begnas village is located 15 km northeast from Pokhara in western region. It has warm temperate to sub-tropical climate. The village extends between 669m and 1430 meters in altitude. A mean temperature of 20°C and a total rainfall of 3999 mm per year is recorded. Indo-Aryans[1] form a major fraction of the society although a minority of Tibeto-Burmans[2] inhabited there. Kachorwa village is located in Bara district. The climate is sub-tropical and the mean temperature is 25°C. The altitude is 80 meters. Rainfall is around 1500 mm a year. Throughout all of the villages, above 70 per cent rainfall is received during June – September (Poudel, et al., 1999).

Like Begnas, almost all inhabitants in the rest of the villages are Indo-Aryans whose livelihoods are primarily dependent on crop production. In these study areas farmers have been cultivating different named rice and taro varieties. Among these villages, there is greater variation of rice and taro diversity in Begnas followed by Kachorwa and Talium. This diversity generally corresponds to dietary richness including local dishes. The above description shows that variation exists between villages both for natural and social factors. Variation in access to market and roads across villages has further influenced the status of crop landraces linked to food traditions.

RESEARCH METHOD

This research is divided into three parts. The first part describes landraces linked to food tradition. This knowledge had been acquired using participatory approaches including focus group discussion, direct observation and interaction with local informants. The second part describes the formulation of new recipe development and organo-leptic tests using panel members. The third part of the research briefly elaborates reciprocal testing of landraces to see environmental effects on the cooking quality of rice varieties.

ACQUISITION OF TRADITIONAL KNOWLEDGE

In the first place, materials related to Nepalese food traditions, their meanings and traditional dishes are described, and research data on traditional dishes thereafter. Materials were gathered through researchers' field experience, observation and focus group discussion (FGD) with farmers. In each FGD, 8-10 "nodal farmers[3]" (Subedi et al., 2001) were involved. The majority of farmers who participated in the discussion were female farmers who had most knowledge about food traditions. However, those known male cooks identified locally were also invited. Through observation and FGD, farmers' ways of describing meals and the elements were gathered. Information on the patterns foods are served, the ways local dishes are prepared and the seasons they are consumed was also inventoried. The case studies are basically food traditions related to rice and taro.

SENSORY EVALUATION OF TARO DISHES

Topical focus group discussions were held with experts such as cooks, marketers and service providers. Since marketers are familiar with consumers' preferences, inclusion of their perspectives in the research process was assured. The scope and need for elaboration of local dishes were explored. The group identified few potential dishes for elaboration. Locally known taro landraces from Begnas and Kachorwa were used in popular urban dishes, namely curry, dip fry and Samosa[4]. Three popular landraces, 'Panchamukhe' and 'Hatipow' from Begnas and 'Ujarka' from Kachorwa were chosen. They were tried with a variety of ingredients mainly fish, mutton and legumes. The snack dish 'Samosa' was tried with 'Ujarka', a known landrace in place of potatoes. Different combinations of tested dishes are presented in Annex 1. These dishes underwent organo-leptic evaluation.

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[1] Genetically identifiable race with long nose and deep eyes of Indo-Aryan origin and follow Hinduism

[2] Genetically identifiable race with flat nose, Tibeto-Burman origin primarily follow Buddhism

[3] Nodal farmers are innovative, knowledgeable and those maintaining high number of crop landraces and also provide services

[4] Popular snack in plain *Tarai,* a triangular shaped dish prepared by mixing mashed potatoes, spices, chopped onion, which is wrapped by thin layer of wheat flour and dip fried in oil.

To assure consumers' representation, three panel groups representing farmers-custodian, urban housewives, and expert cooks were assembled. In urban and rural societies, women, as most known cooks are still women, were invited for the evaluation. Other members already familiar with traditional dishes were also invited. Since hotel cooks are familiar with the wide range of consumers' taste, from local elites through to outsiders, they were invited for evaluation.

Through the discussions, five parameters namely taste, colour, appearance, texture and aroma were considered. Prior to being served dishes, panel members were briefed on the evaluation system. The panellist ranked dishes as good (5), medium (3) or poor (1) according to the parameters. The panellists rated items using appearance, texture, softness, taste and cooking quality. The weight was estimated using a formula: rank assessed by individual panel response x individual score for each good (5), medium (3) and poor (1) category (Devinder Singh, e-mail comm, 2002). The experiment was conducted in Pokhara Tourism Training Centre and involved local farmers and panellists from around Pokhara.

ASSESSING EFFECTS OF ENVIRONMENT FACTORS ON RICE COOKING QUALITIES

In this section we explore how farmers adapt landraces to suit food traditions under variable environments. To understand preference variation, examples with rice landraces linked to food traditions are discussed. 'Jumli marsi' a landrace native to Jumla is well known for cooked rice. It is said that a visit to Jumla becomes memorable if one tries rice from 'Jumli marsi' served with mutton and bean soup. Despite a brown grain colour, low grain yield, and coarse grain (Rijal, et al., 2003), 'Jumli marsi' remains a popular landrace. For this reason 'Jumli marsi' fetches premium price. 'Anadi rice' landrace, native to Begnas with sticky, coarse and chalky grains, makes a special dish locally known as 'Latte'[1]. This dish is served on specific occasions. Despite low yield, Begnas farmers still grow another aromatic, fine grain rice landrace 'Jhinuwa'is another landrace known for its quality. The above landraces are grown under fertile lands with irrigation. Despite contrasting characters, these landraces fetch premium prices in local markets. That means that the grain price does not necessarily indicate grain quality, but the specific use value determines market price. It was learned that 'Anadi' along with other landraces grown in the uplands such as 'Rato ghaiya', are considered impure and, therefore not accepted in social or religious functions. By contrast, fine and aromatic landraces grown with irrigation are acceptable for such social functions. It would seem that upland rice landraces are primarily maintained on economic grounds rather than cultural and further that rice landraces with cultural values are cultivated under irrigated ecosystems. This is important to know as landraces are being displaced by so called high yielding modern varieties. It is unknown whether or not culturally valued landraces can be grown in marginal or upland areas where options are limited.

To see the effects of moisture regimes on culinary characters, three distinct rice varieties were studied. Locally defined moisture regimes include Sinchit (irrigated), Tari (rain fed) and Ghaiya (upland). Culinary characters of 'Anadi' and 'Jhinuwa' were compared with an improved variety Khumal 4, grown across all ecosystems. The above cultivars are native to irrigated low land. Ten panellist farmers invited from Begnas evaluated landraces for cooked rice.

STUDY FINDINGS

The research results are presented in three sub-sections. In the first section the knowledge acquired on local diversity of landraces and food traditions including food habits are

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[1] generally fried with ghee to which substances like sugar, spices, and medinical herbs are added

described. In the second section results from of panel assessment of taro dishes are elaborated. Cooking qualities of rice landraces assessed over environment factors are presented in section three.

NEPALESE FOOD TRADITIONS

Nepalese foods can be grouped into 'primary' and 'secondary' meals, as suggested by Douglas (1997). Of these, two main meals are here termed 'primary meals'. A complete meal consists of dishes from cereals, legume, vegetable, milk or ghee and pickle. The most common meal consists of 'Daal' (Legume soup), 'Bhat' (Boiled rice or maize grits or gruel) and 'Tarkari' (vegetable fry or curry), both in urban and rural settings. Pickles with hot and sour tastes are other desirable elements. Nepalese food traditions are complex and they vary by location, ethnic group and consumers' preferences.

It was known that the dishes forming a meal differ from one village to another. The common dishes for primary meals are derived from wheat or maize and legumes. The meat items are, however, served occasionally on non-ritual festive and ceremonies. Such dishes are considered energy giving. To allow proper digestion, one needs rest and, therefore, heavier meals are eaten in the evening. The dishes served at different times vary from one location to another depending upon the crop varieties grown. A glimpse of local dishes served at different times of the day is presented in Annex 2.

The dishes served each time differ from one another. In all villages, tea is served with milk and sugar particularly to guests and thirsty family members. Tea as a common drink is served in any gathering or function. Farmers experience that milk tea with strong sugar gives instant energy. Tea for this reason is sometimes served instead of a snack, particularly when a meal will be served late.

In villages, farmers adopt a variety of ways to fulfil dietary requirements. The selection of elements for the later meal depends on what was included in the previous meal. Unlike primary meals, secondary meals locally known as 'Khaja' are light and served twice a day, as breakfast or a midday snack. However, 'Khaja' among rural inhabitants is served only under specific conditions. It is served to members going out who expect to be late back to join in family meal or because the forthcoming meal will be served late. Midday snacks are heavier than those eaten as breakfast. Midday snacks are popular among farm workers as they are eaten to regain lost energy. The locations where specific items served as breakfast and midday snack are presented in Annex 2. Beaten rice, yoghurt and fried potatoes are such common and preferred snacks served at breakfast or midday, however, instead of beaten rice, boiled potatoes and bread prepared from millet, barley or wheat are common where rice production is very low. It was also learned that some rice landraces are preferred for beaten rice than others.

Milk is an inseparable element in Nepali dishes. Since farmers keep a few animals, milk may not be available all the time. When milk is in short supply, it is mainly served to physically weak members such as elderly people and young children. The present study on food culture shows a varying degree of associations between dietary richness and the amount of crop diversity at species and intra-species levels. The maintenance of local crop diversity also interacts with other components such as livestock. Increased production of milk and milk products can motivate consumers for using beaten rice, which in turn can provide farmers' incentives to grow suitable rice landraces. In other words, the maintenance of traditional dishes derived primarily from local crop diversity will maintain on-farm diversity.

PATTERNS OF SERVING FOOD

The meaning of eating differs with regard to the dishes that form a meal and to the ways a meal is served. The dietary diversity varies over locations, which across all villages has been both symbol and sign. Apart from wealth, caste and education, the elements that form a meal and the ways meals are served indicate household prestige. The dishes to be served vary directly by age group, nature of jobs they do, and by positions they hold in the society. The household cook ('Bramhin') who serves guests with a variety of dishes in a brash plate and with cups on clean mats, spread all on cow dung smeared floor, symbolises respect. Certain norms are followed in serving meals. Heads of the household and guests are served first but other key family members may join in provided there is enough space. The same cuisine is served to those members who enjoy meals together. Those are elite members receive priority for food that is more appealing, attractive and energy - giving. The dishes and the patterns of serving food symbolises household status. A village story tells about how social norms are linked to social prestige. Serving rice dishes at every meal is particularly important to people where rice production is very low as complements to dishes derived from millets, buckwheat, maize, potatoes or wheat. To secure household prestige, the cooks prepare two separate dishes one from rice and one from other cereals. These dishes are served in a strategic manner. The cook knows that people will still enjoy porridge when they are hungry. Such order of service probably reduces the chance to make any complaints against the food and the cooks in particular. There is a custom that a 'Bramhin' wearing sacred threads should leave small amounts of rice to give away to lowly spirits that appear as pet animals or birds. Again they need to put some rice aside and come out to wash their hands to prove that they have eaten rice. Belching is not liked though it is common after the good meal. Also to create a feeling that they have had a good meal, tastier dishes such as rice are served last. Such practices are rare for any meals taken in the evening, except those nights when the family is hosting visitors or relatives.

Social position of a household is relative, which may vary from one location to another and can be predicted against the dishes they serve. Farmers of low rice producing areas may secure higher social position if rice dishes are included in regular meals. The choices of species are important. Unlike Talium and Begnas, Kachorwa farmers select landraces within the rice crop. Prestige in such cases is based on whether the meals are prepared from quality landraces. In addition, the number of times dishes are served and the number of dishes that form the meal symbolise social prestige. Wealthier families with high social status serve more dishes than poorer families.

In all study villages, slightly different food privileges and serving patterns were found for men and women. The significant food privilege for men was unique to Talium. The regular meals and popular dishes are served to male members and children. In particular cases, women can have food privileges during her post delivery period. Women who gave birth to a boy (but not a girl) enjoy special food dishes[1]. In public celebrations, ceremonies and ritual functions, common dishes are served. The order foods are served follows head of household then men and then women. The children are served in the beginning or in separately. The cooks (woman) always take their meal last, and not with rest of the male members. There is a custom that the wife uses the same plate with the leftover meal after her husband. Prior to eating main meals, married women often greet their husbands. These sorts of traditions are still prevailed in rural villages e.g. Talium. The impacts of serving patterns and food preferences can be twofold. The household heads having food preferences may influence household decision in selecting particular landraces even if there are alternative options.

SYMBOLIC TRADITIONAL DISHES

Rice for Hindus is not only a staple crop but is also known to have diverse symbolic meanings. Rijal, et al., (1998) documented different rice dishes prepared from specific landraces are used for symbolic offerings to the Gods and Goddesses. Over 18 festivals and

[1] Delicious dish prepared from locally known rice landrace (Jumli marsi) with legume soup mixed with mutton

nine ritual functions were reported to require a variety of rice dishes (Pant, 2002). None of the Indo-Aryan religious, ritual or cultural functions are complete without the inclusion of rice pudding (Khir). Special dishes are required for offerings to lowly spirits (Ghost), spiritual forces such as Gods, and lineage Gods. Descendants made symbolic offerings with rice balls (Pinda) to the past ancestors in rituals ceremonies (Shraddha) (Stone, 1978). 'Bramhin' male who have sacred threads use rice as symbolic offerings to their descendents prior to primary meals eat. Unlike rice, taro can have slightly different symbolic meanings. Descendents offer taro leaves to mediate spirits of past ancestors in ritual ceremonies. Since root crop species are considered "pure" taro corm/cormels are eaten during Hindu festivals specially Maghe Sakranti and Shiva Ratri. Specific landraces are chosen for such dishes and / or for social and religious functions. Hindu women will have to have cultural and religious meal prepared from taro landraces that produce single shoot and rice varieties of local origin. Farmers know that taro seeds planted without ploughing give single shoots. Those landraces with ritual or cultural values are often grown in small patches.

Our experience is that inter and intra species diversity has strong links with religious and social norms. Even today social status is among other things judged against: a) the amount of rice produced, b) the frequency aromatic rice is eaten at regular meals c) the number of quality rice varieties grown, and d) growing landraces with religious, cultural significance and special uses. Farmers with high rice diversity are ranked high in their societies. Social prestige seems to provide a certain degree of motivation to conserve crop landraces.

TRADITIONAL TARO DISHES

Like other species, taro provides ingredients for important dishes in the Nepalese diet. Local farmers prepare a variety of dishes from leaves, petioles and corm or cormel. The common ways different dishes are eaten include vegetables, curry and boiled and dip fries. Certain traits are preferred for specific dishes. Acridity is such a trait that is common in taro. Begnas farmer Chizamaya Gurung metaphorically compares acridity and states: "taro without acridity is to say like a snake without poison" but what matters for her is the degree of acridity. Since local techniques are developed to normalise acridity[1], any promising landraces are still grown even if they are acrid.

Certain landraces are preferred for some dishes with other multiple uses. In Begnas, 'Dudhe karkalo' is known as a landrace for pickles, leaves and young shoots. 'Panchamukhe' and 'Khujure', both cormel types, are preferred for dishes prepared from leaves and shoots. In general, landrace diversity corresponds to the dietary richness. However, this is not always so. Talium and Kachorwa farmers prepare about six dishes from a single landrace. In Begnas, at least 13 different dishes are prepared whereas more than 16 landraces are grown. The study revealed that the majority of dishes are common dishes but a few dishes are location specific. In all villages, fresh leaves, shoots and cormel were identified as common items. Despite absolute uses, taro products are also used as ingredients in snacks or other curry or vegetable dishes.

'Pakauda'[2] is such a popular dish and is eaten as midday snack in Kachorwa. Likewise, 'Masaura' is prepared from young shoots and also from the corm. However, these are prepared from shoots and also from corms. The fresh shoots or corms when cut in smaller pieces are semi-dried in the sun. The dish is prepared as soon as the raw materials are dried. Processed nuggets with a triangular shape, uniform size and green colour are preferred. To keep the natural colour and to avoid any bad smell, nuggets are dried under shed. Well-dried nuggets are packed in earthen or bamboo structures and can be stored for several weeks if kept in a dry place.

[1] Products are treated with lemon, salt and chilly powder

[2] Hexagonal shaped dip fried structure prepared from cut onions, flour and mashed potatoes or from taro. Popular in Kachorwa

There are seasons or occasions during which certain dishes are preferred. 'Masaura'[1] for example, is considered as an all season dish whereas 'Tandra'[2] soup / curry is considered best when served during the dry season. The fresh leaves are eaten from summer until early winter, and corm and cormel during the spring months. The majority of the products are consumed in dry spring seasons particularly when fresh vegetables are in short supply. It is evident that in Begnas the richness of local dishes correlated positively with landraces diversity. In other villages, multiple dishes are prepared from a single landrace suggesting that use value differs from one landrace to another. The similar is in the case of Begnas. Landraces with multiple uses are popular compared to those with specific uses. Local dishes have served as a 'driving force' for conserving landraces. In other words, the promotion of local dishes enhances conservation of landraces along with food traditions. Through discussion, we recognize three bottlenecks that prevent their promotion: 1) traditional systems are not good enough to produce quality products 2) there is a lack of reliable supply systems throughout the season as per consumers' demand, and 3) there is a lack of local and research base information including recipes as per demand of urban consumers.

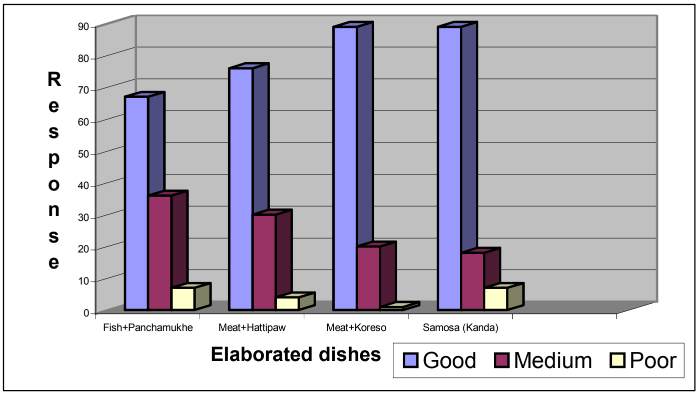


Fig. 1: Panelist response to elaborated dishes

ELABORATION OF TARO DISHES

Traditional taro dishes were served alone or mixed with other ingredients. Farmers expressed that the taro tasted best when cooked with grain legumes or potatoes. Such practices are also occasionally seen in urban societies. We hypothesize that the demand for taro derived products will be expanded if: a) dishes are elaborated to make them more appealing and attractive, and b) consumers' access to elaborated dishes is improved. It was learned that poorly processed and packed dishes combined with unreliable supply are not attractive to urban consumers. We assume that local dishes need to be elaborated to make them appealing and attractive. Locally known dishes were elaborated and tested to examine consumers' preferences. Locally known traditional dishes were evaluated combined with popular items including fish, meat, legumes and Samosa.

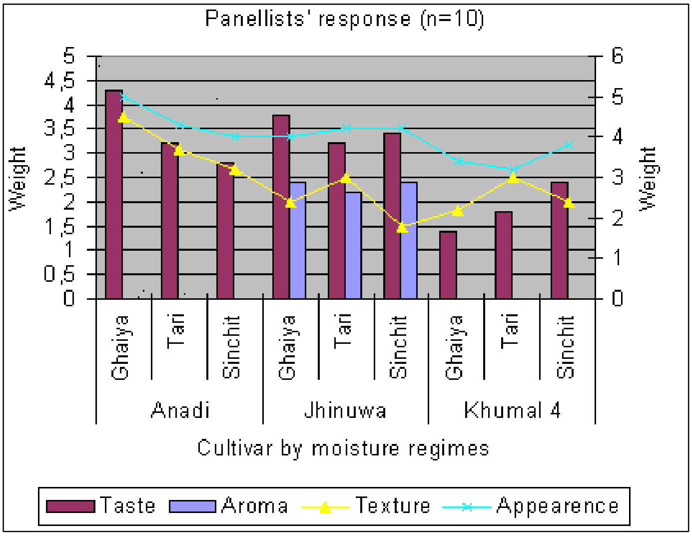
CULINARY CHARACTERS OF ELABORATED TARO DISHES

The panellists liked all the elaborated dishes, although some dishes were preferred more than others. Samosa was assessed best with 'Ujarka'. Other preferred dishes were fish curry prepared with 'Panchamukhe' followed by dip fried mutton with 'Hatipow'. The most liked dishes are presented in Figure 1. 'Hatipow' seemed more compatible when cooked with

[1] A traditional triangular nugget made from taro petioles or corm and black gram flour, In Begnas, the dish is served to guests, visitors or close relatives. A gift pack of 'Masaura' is given to relatives, friends living outside village or abroad

[2] Item prepared from the young semi-dried shoots, chopped longitudinally and dried under the sun. They are weaved like a ponytail and hung in dry and protected places.

mutton. 'Panchamukhe was largely preferred for curry dishes. All three panel groups unanimously rated 'Ujarka' to be the best landrace for Samosa. Certain trends were observed about consumers' preference. Farmers and housewives preferred dishes that are prepared with mutton followed by fish and legumes. Both farmers and housewives rated elaborated dishes in similar ways except for fish curry with 'Hatipow' and 'Samosa'. Farmers liked Koresho and 'Hatipow' with mutton and ranked 'Samosa' thereafter. Expert cooks and housewives liked 'Samosa' most and Koresho with the mutton thereafter. Curry dish when cooked with Tandra mixing with potatoes was disliked by farmers and housewives. Unlike farmers and housewives, curry mixed with peas and 'Hattipow' was surprisingly liked by expert cooks. Unlike expert cook and housewives, farmers also preferred Koresho even with peas (Figure 1, Annex 1).



Response: Total panellist x individual ranking as Good (5), Medium (3) and Poor (1)

This shows the choices can be both common and panel group specific. It may, therefore, be unjust to generalise the preference trend based on the results of a limited panellist response. This information however, gives a basis for the selection of elaborated dishes for promotion purpose.

Fig. 2: Effects of moisture regimes on culinary characters of rice, Begnas
Note: Higher the score greater the preference

CULINARY CHARACTERS OF COOKED RICE

The study revealed that the taste of cooked rice vary by ecosystem and cultivar types (landrace or improved). Both landraces 'Anadi' and 'Jhinuwa' had an even better taste when grown in the uplands. Khumal 4 an improved variety, on the other hand, had a better taste when grown under its originally recommended ecosystem. Unlike improved variety, both landraces gave promising results as far as culinary characters are concerned. The rice aroma was better when grown under Ghaiya and Sinchit than in Tari (Figure 2). Regardless of cultivar types, the texture of cooked rice was better when grown in Tari. However, 'Anadi' grown under upland ecosystem always tasted better.

The above results led us to make few remarks. Despite low yields, irrigated landraces can be grown under upland conditions as far as culinary character is concerned. Since farmers make their own choices of comparative benefits, the new options could be an effective method for the conservation of food and cultural diversities. Since improved varieties show specific adaptation they are rarely preferred when grown under upland conditions. Provided economic yields are competitive with other options farmers have, irrigated rice landraces had better quality grain when grown under rain fed and upland conditions. This suggests that culturally valued landraces even if displaced from their original habitats may be conserved in alternative production ecosystems.

DISCUSSION AND IMPLICATIONS

Nepalese food traditions are full of symbolic meanings and they vary according to the context that they are used and the way they are served. They have substance value if eaten as food, and the same dish is symbolic if it is offered as mediation to the Gods, Lineage Gods or lowly Spirits during ritual or religious functions. As Stone (1973) described, social prestige is directly linked to food traditions, and indirectly linked to crop landraces. Farmers' reasons for the present day landraces are the relative benefits and values e.g. substance and cultural. The ground where the present landraces are grown may change over time in accordance with changes in peoples' perception. Traditional food habit and the recipe that makes a complete meal play important role to maintain diversity. The recipes included in ordinary meals indicate food traditions play important roles in conserving diversity. Local preference for some crop species, varieties for specific dishes which are served either in ordinary meals, religious or cultural meals provide community incentive further to maintain diversity on-farm. Along with the socio-cultural and food values diversity is maintained due to environmental variation. As depicted in Figure 2 some landraces are preferred when grown under certain environment while others under different environments. For instance, the high quality rice landraces give real taste only when grown in their original habitats e.g. sinchit. This suggests that landraces are maintained for different non-material values, economic and ecological benefits.

These landraces that have multiple values and uses e.g. 'Jhinuwa rice' are likely to be maintained on-farm. Likewise, crops landraces with non-substance values are likely to be continued as long as social norms, culture and food tradition are maintained. The fate of landraces therefore is greatly dependent on the conservation of socio-culture, social norms and degree of compliance of food traditions with modern food science.

Landraces with specific uses are maintained because certain dishes are popular. The fate of landraces with substance value is however dependent on their potential to offer services and benefits to local people. Integration of such elaborated dishes derived from locally adapted and socially valued species in common cuisine may expand food markets. Elaborated taro dishes when integrated with mutton could be popular among urban consumers. The promotion of elaborated dishes may attract more consumers, which provide incentives to different parties including farmer- producers. Conservation of crop landraces can thus be strengthened, provided the demand for their derived products are created or expanded.

In addition to describing local food traditions, we present two different approaches through which market demand for crop landraces are created and or expanded. As indicated earlier, the elaboration of food traditions has been found effective in expanding consumers' demands. Most crop landraces are not as productive as modern varieties particularly when grown in fertile lowlands. It is imperative to explore ways and areas where such culturally valued but less productive crop landraces may be grown successfully. Research results have shown that some landraces grow well in alien environments suggesting that some landraces displaced from their original habitats, may be grown to newer habitats where farmers options are limited. This approach has shown that farmers can grow certain landraces even in new environments if the demand for their products could be expanded.

It is worth discussing how peoples' livelihoods are addressed when conserving food and cultural diversities. Food traditions are an important subset of the peoples' livelihoods. Livelihoods may be considered secure when consumers' have good access to traditions as per their preferences. Crop landraces that are often linked to local food traditions are being displaced with the growing popularity of the modern varieties. Farmers are thus being discouraged to continue growing crop landraces.

One way of creating farmers' incentive to continue crop landraces is through expanded demand for their derived products. Results have indicated that the promotion of elaborated foods benefits every actor involved from producers through to consumers. Urban consumers may introduce new dishes in their meals. As shown in Annex 2 traditional food habits that are developed based locally cultivated diversity are increasingly threatened along with improved access to exotic and processed foods including takeaways e.g. pancake, pizza, noodles and spagetty. Though increased diversity of food dishes help improve food and nutrition it only assures diversity maintenance only when new food recipes are developed based on the locally cultivated food crop species. To do that food research initiation should be given due attention.

The farmer benefits from landraces if the demands for derived products are increased. It is likely that increased income may allow farmers to buy cheaper foods (processed) accessed locally. Urban consumers benefit if elaborated dishes are supplied to the markets. Through such efforts the different actors would mutually benefit each other. Kahn (1988) argued that adding values to food traditions is not only to replace imported foods but also to provide more options for consumers. This would monopolise food markets through promoting food traditions but provide more options to consumers and thereby enhance peoples' livelihoods. If the multiple strategies as above are in place, we argue that diversities and livelihoods go hand by hand.

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Annex 1: Results of sensory evaluation of elaborated dishes, LI-BIRD (2002)

Panel group/Elaborated dishes	Expert cook	House wives	Farmer
1. Fish curry + Panchamukhe	4.4	4.2	3.9
2. Fish curry + Hattipaw	4.0	4.3	3.7
3. Fried mutton + Hattipaw	4.6	4.3	4.3
4. Curry peas + Panchamukhe	3.4	4.0	3.8
5. Curry peas + Hattipaw	4.5	3.6	3.4
6. Curry peas + Koreso	3.3	3.8	3.8
7. Fried mutton + Koreso	4.6	4.7	4.6
8. Mutton curry + tandre + Patato	3.5	3.5	3.3
8. Samosa (Ujarka)	5.3	4.9	4.1

Note: Panellist given score x rating score for each good (5), medium (3) and poor (1) / total potential responses by consumer category

Annex 2: Description of regular cuisines of Talium, Begnas and Kachorwa villages, Nepal.

Meals in priority order, I= High	Villages		
	Talium (Mountain)	Begnas (Mid-hill)	Kachorwa (Tarai)
III. Breakfast or Bihanko Khaja (6-8am)	a. Tea © + b. Boiled potatoes/ c. Millet bread/ d. Roasted barley flour e. Noodles f. Left over meals served to children	a.Tea ©+ b. Boiled egg (O) c. Puffed corn/ d. Puffed soybean or d. Noodles or e. Milk only f.Left over meals served to children	a. Tea © + b. Boiled egg (O) c.Beaten rice+yogurt+Curry d. Biscuits / e. Noodles/ f. Bread /Loaf/ g. Milk only or h. Left over meals served to children
I. Morning meal or Bhat (9-10am)	a. Vegetable curry ©+ b. Beans soup/ c. Fermented dish (OS) c. Boiled rice / d. Millet bread e. Whey (O) f. Yogurt (O)	a. Vegetable curry © b. Legume soup/ c. Fermented Dish (OS) d. Boiled rice / e. Boiled maize grit / f. Millet porrige / g. Milk / whey+ h. Pickle +	a. Vegetable curry ©+ b. Legume soup+/ c. Fermented Dish (OS) d. Boiled rice©+ e. Yogurt or whey (O) f. Fried potatoes (F)+ g. Nutrella (OS) h. Pickle + i. Ripen mango (S) +
II. Midday snack / Diusoko Khaja (2-3pm)	a. Tea ©+ b. Millet bread / c. Buckwheat bread / d. Boiled potatoes / e. Puffed corn + Whey f. Noodles	a. Tea ©+ b. Beaten rice +Yogurt + Curry c. Sweets + Curry / d. Samosa + Yogurt / e. Biscuits/bread / f. Puffed corn+ Whey/ g. Puffed rice + Pickle h. Noodles i. Wheat chapati + Vegetable curry	a. Tea ©+ b. Beaten rice+Yogurt + Curry/ c. Samosa + Yogurt/ d. Sweets + curry / e. Boiled potatoes + Whey/ f. Puffed maize + Whey/ g .Puffed rice+Fried potatoes/ h. Biscuits/bread i. Noodles j. Wheat chapati + Vegetable curry
I. Evening meal / Belukako Khana (6-7pm)	a.Vgetable curry / b. Beans soup+© c. Millet bread d. Buck wheat bread / e. Boiled rice (P) f. Barley + millet bread/ g. Wheat bread h. Whey + i. Meat (OC) j. Fish ® k. Egg ®	a. Vegetable curry / b. Black gram soup ©/ c. Masaura (OS)/ d. Nutrella (OS)+ e. Maize grit / f. Wheat bread / g. Millet porrige / h. Whey + i. Meat (OC) j. Fish (FSS) k. Egg ®	a. Vegetable curry © b. Lentil soup ©+/ c. Nutrella (F) d. Wheat bread / e. Cooked rice / f. Milk or whey+ g. Meat (OC) h. Fish (FSS) i. Egg (F)

Note: © = common element, O = optional dishes, ®=Rarely served dish, FSS=Frequently served dish in particular season, OC=Dish served in special occasion, OS=Off-season served dish,/=Alternative or optional element of a meal,+/=Dish served along with or with alternative dish. Bold dishes are imported or junk foods or those foods replacing local foods. Source: Focus group discussion (2002).

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POULTRY PRODUCTION, MANAGEMENT AND BIO-SECURITY MEASURES

Banshi Sharma, MVSc.[1]

ABSTRACT

Poultry farming is an emerging industry in Nepal. Hygienic poultry production can pave way to better income and sustainable development. Poultry health management is important due to emergence of highly pathogenic diseases like Highly Pathogenic Avian Influenza (HPAI) in different parts of the world. Bio-security measures become vital for better performance and quality of poultry production in competitive world. The latest technological innovations may help adoption of bio-security measures and environment friendly practices in poultry production system. Bio-security policy can be formulated with the participation of stakeholders. It would give new dimensions towards poultry farming in different clusters in Nepal. Moreover, participatory response of poultry entrepreneurs to the programs prioritizing poultry disease investigation, eradication and safe guarding poultry industry would be valuable. There must be research tie up with different institute regarding production, processing and marketing of poultry products.

Key words: Bio-security, environment, Nepal, poultry health management, poultry performance, quality-control.

INTRODUCTION

Poultry health management is the emerging issue along with bio-security measure. Livestock and poultry birds are major causes of zoonotic diseases transmission chain. The food from livestock sources need to be free from disease causing agents to safe guard public health. Farm to fork chain must be clean and hygienic. Therefore, bio-security is foremost important to poultry farmers. It reduces losses in long terms. It promotes organic farming in rural area. Bio-security measures, poultry farm management and organic farming become sustainable development cycle in rural area. Farmers used to keep few birds in scavenging system in villages and have been keeping native chicken in backyards. Therefore there is a chance of spreading of poultry disease in livestock and human population due to close contact. It should be avoided for better sanitation practices in long run. There is a tremendous growth of poultry farming in the last six decades and it creates income generation in urban and per urban area (Bhattarai, 2007). The demand of poultry meat has increased due to tourism and changing food habits.

In the year 2004/2005, poultry meat production was 15,461 MT (Annex 1). There is a gradual increase in poultry meat production. Duck is basically raised for religious purposes in different places. The duck is localized in towns, roadside area, peri-urban area and swamp area of villages. They are more concentrated in riverside and water logging areas. High duck population may serve as carrier of HPAI and Low Pathogenic Avian Influenza (LPAI) in poultry population.

There has been gradual increase in poultry egg production, and in the year 2006/2007, it reached 614,848,000 in Nepal (MOAC, 2008). The poultry population including layers and broilers are gradually increasing. There had been 6,643,350 layers in Nepal in the year 2004/2005(Annex 2).

A lot of women are involved in poultry processing. Development of infrastructure for slaughter house has been very slow. Local government should participate with private sector. The land for slaughterhouse, water supply, sewage and organic materials decomposition place should be well organized. The construction of slaughterhouse is to be

[1] Senior Veterinary Officer, Central Veterinary Laboratory, Ph. 4261938, sharmabanshi@hotmail.com

provided by municipalities, private entrepreneurs and VDC in joint venture programme. The key role of maintenance should be given to private sector for making sustainable development.

Now a days people enjoy different types of poultry meats such as Mandarin chicken, chilly chicken and Thai chicken. They have developed habit of eating frozen meat. When people have exposure to outside work, they learn to eat different varieties with their changing lifestyles. The processed and frozen meat has local market and tourists are major consumers. The government may help by providing opportunity of exporting in neighbouring countries as well as overseas. For that there must be eradication of Salmonella in poultry birds. Therefore, zoning concept may be applied for this. As Nepal becomes member of WTO, if we met SPS standards on poultry meat and eggs, export becomes easier than expected.

Bio-security policy, rules, and regulation can be accommodated to the existing laws of Nepal. In the advent of bird flu outbreak in Nepal, bio-security policy formulation has been initiated. Therefore, in order to obtain hygienic poultry production, livestock market, processing activities and farm should follow bio-security to make hygienic environment. The objective of the review is to help develop environment friendly poultry farming system to obtain maximum production without damage to environment.

THEORETICAL FRAMEWORK

Considering the important contribution of poultry sector in national economy APP has given it third important priority in livestock development programme. There is a growing trend of poultry keeping in the highway sides and other roadside area. Currently there are five hatcheries in government sector and 75 hatcheries in private sector. Similarly there are 178 feed industries in private sector and one in government sector. There is a tremendous potential for poultry development in future. The future strategy may include steps and policy to marketing level. Poultry farmers have better economic opportunity. It gives also employment opportunity to women and rural people.

There should be relation between poultry development and poultry health plan to improve public health hazard in the country. At present, there is little infrastructure to facilitate the slaughter and marketing of poultry birds. Though there are some cold storage and meat marketing scheme in private sector. Egg market is tied up with feed industry. There is lesser concern towards the environment protection. Therefore, it is advisable to have following strategies for betterment of poultry production, management and good bio-security measures that improves the production in and environmentally friendly manner.

There must be clear cut vision about commercial as well as rural poultry development. There is ample opportunity of exporting eggs and meat in autonomous region of Tibet, China, Bangladesh and Gulf countries. The government should take initiatives for standardization for exporting. It will create confidence in rural farmers. There is an urgent need of poultry development board in which there must be participation of producers, hatchery owners, feed industrialist, medicine suppliers', livestock experts, veterinarian, management experts and planners. There must be soft loan programme towards poor farmers and women group. There must be workable mechanisms of quality control of chicks, feed and medicines. There must be policy for infrastructure development such as slaughterhouse, cold storage etc. The processed product can fetch more money. There should be bio-security policy along with environmentally friendly plan for farmers and entrepreneurs.

Special package is organized (training in poultry keeping, poultry processing) for group leader farmers in rural area and commercial farmers of poultry production area. Commercial poultry production is 50% and rest 50% occupies by back yard poultry production. Special focuses on disease know how, treatment of poultry birds by technicians or experts would be done. Poultry extension programmes through Department of Livestock Services (DLS), NGO and local government should be carried out in a coordinated way. There is Central Veterinary Laboratory (CVL) in Kathmandu and National Avian Investigation Laboratory (NAL) in Chitawan, which deal with the poultry disease diagnosis. The capacity of CVL and NAL shall be enhanced to cope with emerging poultry diseases.

Research on production, processing and marketing of poultry products is essential to increase productivity and to maintain good environment. The role of private sector is limited to management and processing of poultry meat. These municipalities should develop infrastructure in suitable places. Experts of DLS and National Agriculture Research Council (NARC) shall provide clean meat and sausage production training. There must be some sort of training on marketing component, which should be explored. The bio-security measures should be worked out and published for general public and stakeholders.

BIO-SECURITY FOR POULTRY FLOCKS

Bio-security has three major components: isolation, traffic control and sanitation. Whenever there is import of new chicks from abroad, it shall be quarantined for three weeks in respective farms. Sick birds shall be kept in isolation. Different age and sex groups shall be placed separately to minimize the risk of disease spread. Poultry health management and treatment procedure shall better organize by means of isolation. The possible breakdowns in bio-security norms and introduction of new birds and traffic pose the greatest risk to bird health. Therefore, properly managing these two factors should be a top priority in a farm. In order to assess how much bio-security is practical in a farm, following factors such as economics, common sense and relative risk should be considered.

New birds represent a great risk to bio-security because their disease status is unknown. They may have an infection or be susceptible to an infection that is already present in birds that appear normal (healthy carriers) in a farm. While all-in/all-out management system is not feasible for many breeding farms or farms raising exotic fowl or game-birds, it is possible to maintain a separate pen or place to isolate and quarantine all new, in-coming stock from the resident population. Isolation pens should be as far from the resident birds as possible. At least 3 weeks of quarantine is preferable; 4 weeks is better. Observation of birds for any signs of illness shall be observed regularly. Diagnostic blood tests for infectious diseases shall perform at this time. Avoid putting new birds, including baby chicks, in contact with droppings, feathers, dust and debris left over from previous flocks. Some disease-causing organisms die quickly; others may survive for long periods (Annex 3). Footwear should be disinfected at each site. Disinfectant footbaths may help to decrease the dose of organisms on boots. But, because footbaths can be hard to correctly maintain it is a good idea to have a supply of cleanable rubber boots or strong-soled plastic boots for visitors. It is advisable to wash hands after handling birds in isolation or birds of different groups. It is mandatory to disinfect drinkers and feeders on a regular basis (daily). Plan periodic clean-out, clean-up and disinfection of houses and equipment, at least once in each production cycle of poultry bird. Use this time to institute rodent and pest control procedures. Remember that drying and sunlight are very effective in killing many disease-causing organisms. Dispose of dead birds promptly by rendering, burning, burying, composting or sending to a sanitary landfill.

DISCUSSION

Poultry farming is one of the booming industries in Nepal from last four decades. Poultry farmers are facing a lot of problems due to high cost of feed and medicine, emerging new diseases and lack of bio-security measures. There is outbreak of bird flu in South Asia, East Asia frequently which causes panic among stakeholders. Government policies towards bio-security are not adequate. Backyard poultry raisers and small entrepreneurs will feel burden of bio-security. Though, it is helpful and cost saving mechanism for entrepreneurs in long run. As there are some important zoonotic diseases which spread from poultry to human being such as HPAI make a great concern to us and global environment. Above all the commercial farmers/entrepreneurs have to perform their activities as per the Environment Protection Act 2055. It is advisable to establish new farms out of densely populated area.

The disease reporting system of District Livestock Services Office (DLSO) comes from different services centres of Nepal. They collect information from backyard poultry farms and small commercial farms in the districts. They do not have information from the big commercial farms. So that the epidemiological surveillance reporting is incomplete and it cannot be interpreted correctly.

Bio-security is a means of recommended practices in the farm premises, which costs some extra investment initially however it will be cheaper in long run. Bio-security is necessary to control disease in effective way. The treatment and prophylactic measures and its cost involvement shall be reduced.

There must be awareness and training programme in bio-security measures. Nepal produces different livestock and poultry vaccine of its own (Annex 4) and vaccination of poultry birds as per the schedule is one of the reinforcing bio-security measures in poultry farms.

It is necessary to organize public awareness campaign for different types of poultry meat. With increase in poultry meat variety and diversification in meat processing, more of raw meat tends to be processed. It can fetch more money than raw meat. Tourism is one of the major foreign currencies earning industry in Nepal. if there will be more flow of tourists in future, the market of processed meat will be widened. Poultry farming is providing employment for 65,000 and the rate of employment will increase in subsequent years.

Clean poultry farm will reduce foul smelling to neighbours and disease spread. Poultry manure is good for agricultural product. Organic farming can be boosted along with poultry farming which will ultimately lead to sustainable development and clean environment. The earth becomes global village and each and every person shall contribute to maintain clean environment. One good manage poultry farm will certainly contribute to clean environment. Solid waste disposable systems should be developed. Dead carcasses should be buried with due care so that it will not contaminate soil and water. Food chain, use of antibiotics, decontamination medicine, ecto-parasite medicine should be used rationally to avoid residue in poultry and subsequently to soil, vegetation, food chain and environment. Among the infectious diseases Infectious Bursal Disease (IBD) is one of the major disease problems in Nepal followed by New Castle disease, coccidiosis and pullorum (Annex 5).

Major poultry vaccine imports are ND, IBD, Fowl pox, IB (live), IB+ND, Marek's disease, Reo, Salmonella (Live), EDS-76.There has been restriction of Chicken Anemia virus vaccine and avian encephalomyelitis (AE) vaccine. As there was no such disease outbreak reported in Nepal so far.

CONCLUSION

Poultry production is an important component of integrated agriculture practice in Nepal. Backyard poultry becomes ideal source of cash money to rural people. Where as commercial farmers are interdependent with feed price, market network of eggs and meat. The backyard poultry farming is not up to expectation in term of bio-security and cleanliness measure. After first outbreak of HPAI in 2009, the government of Nepal has given priority for bio-security policy formulation. As the poultry industry is in continuous threat of HPAI, the poultry heath management is of great concern in present situation.

Fifty percent of poultry production is taken by commercial sector. Lack of proper disease recording and reporting system from commercial sector to government organization make knowledge about in country status of animal disease incomplete and unreliable to different stakeholders. Present epidemiological reports include only back yard poultry and small farms. This will hinder information sharing between commercial and back yard poultry farms and can cause substantial economic losses to farmers. Developing environment-friendly poultry farming system is urgent in Nepal with documentation of prevailing diseases.

There should be stakeholders meeting from all sectors of poultry entrepreneurs to guide towards future goal and it gives way to prioritize poultry disease investigation, eradication program and safe guarding poultry industry in Nepal.

There must be research tie up with different institute regarding production, processing and marketing of poultry products. Diagnosis of poultry disease must be given high priority as risk of bird flu pandemic.

Bio-security measures should be enhanced to reduce disease outbreak. Good bio-security will pave way for clean environment. Standards for bio-security measures are in progress. There must be awareness programme to farmers' level to update bio-security need. Clean poultry production system will make hygienic food chain and contribute towards improved farm management. Bio-security will not only maintains the good environment but also minimize infectious and zoonotic diseases and subsequently enhance public health.

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Annex 1: Poultry Meat Production in MT:

SN	Fiscal Year	Poultry Meat	Duck Meat
1	1996/1997	10671	291
2	1997/1998	11400	292
3	1998/1999	12116	294
4	1999/2000	12659	296
5	2000/2001	13259	287
6	2001/2002	14118	281
7	2002/2003	14756	270
8	2003/2004	15881	223
9	2004/2005	15461	237

Source: Statistical information on Nepalese Agriculture 2006/2007

Annex 2: Poultry population in Nepal:

SN	Years	Poultry	Ducks	Poultry Layers	Duck Layers
1	1996/1997	15576525	415758	4886764	218065
2	1997/1998	16164730	416943	5181880	218687
3	1998/1999	17796826	421423	5420900	220400
4	1999/2000	1861936	425160	5667817	222401
5	2000/2001	19790060	411410	5998367	215376
6	2001/2002	21025030	409861	6453860	214090
7	2002/2003	22260000	408311	6622558	213751
8	2003/2004	22525112	400083	6676954	211838
9	2004/2005	22790224	391855	6643350	183208

Source: Statistical information on Nepalese Agriculture 2006/2007

Annex 3: Longevity of Disease-Causing Organisms

Disease	Lifespan away from birds	Disease	Lifespan away from birds
Infectious Bursal Disease	Months	Marek's Disease	Months to
Coccidiosis	Months	Newcastle Disease	Days to weeks
Duck Plague	Days	Mycoplasmosis (MG,MS)	Hours to days
Fowl Cholera	Weeks	Salmonellosis(Pullorum)	Weeks
Coryza	Hours to days	Avian Tuberculosis	Years

Annex 4: Vaccine production in Nepal:

Vaccine Production	F/Y 2060/61	F/Y 2061/62	F/Y 2062/63	F/Y 2063/64
PPR tissue culture vaccine	35,62,000	22,13,000	20,65,000	19,19,000
H.S. and B.Q.	4,57,000	3,94,000	5,86,000	8,58,000
Swine Fever	11,000	19,000	10,000	75,000
N.D. (M strain)	95,76,000	88,22,000	90,80,000	97,69,000
Ranikhet R2B	16,45,000	20,63,000	20,90,000	20,90,000
Gumboro Live vaccine	43,97,000	57,08,000	56,56,000	56,58,000
HS aerosol vaccine	0	25,000	25,000	25,000
HS, BQ, Anthrax	1,22,000	3.30,000	0	0
Fowl Pox	3,74,000	0	0	0

Source: Animal Health Directorate Annual Report 2060-2064.

Annex: 5: Poultry Disease Compilation of 2002-2006:

SN	Poultry Disease	Outbreaks	Affected	Dead	Vaccinated	Treated
1	Coccidiosis	4861	497510	30960	0	493695
2	Respiratory Disease (unclassified)	2989	193020	13153	0	183472
3	IBD	741	294147	29219	651694	230882
4	New Castle disease	592	226594	22298	1042139	55289
5	Pullorum disease (*S. Pullorum*)	364	89072	6254	0	83437

Source: Annual Epidemiological Bulletins of 2002-2006.

FERTILIZER POLICY DEVELOPMENT IN NEPAL

Ram Krishna Shrestha, MSc.[1]

ABSTRACT

Fertilizer is a vital input for agriculture production. With the growing popularity of modern agriculture, fertilizer consumption in Nepal has been increasing over the years. Since, Nepal does not produce any fertilizers, demand for fertilizers are being met through formal and informal imports. Over the years, fertilizer policy changes have been observed several times in a bid to satisfy farmers' demand for quality fertilizers. While fertilizer policy change of deregulating the fertilizer trade initially produced positive impact in overall supply situation, deregulation policy could not largely ensure the supply of quality fertilizers in required quantity and time. Re-introducing subsidy regime in chemical fertilizer by the government's recent decision could be considered as a positive development towards meeting farmers demand for quality fertilizer. However, given the quota of subsidized fertilizer, which is far less than the actual demand, the problem of supply is likely to continue. To address current problem of short supply government should increase the quota at least up to three hundred thousand metric tons. Moreover, Ministry of Agriculture and Cooperatives should come up with a long-term plan aiming at sustainable management of soil fertility.

Key words: Fertilizer subsidy, fertilizer deregulation, fertilizer import

INTRODUCTION

Fertilizer is a vital input for agriculture production. It not only plays direct role in increasing production but also enhances efficiency of other inputs like irrigation and seeds. Twenty-year Agriculture Perspective Plan (APP), which is in implementation since 1997 has identified chemical fertilizer as an engine of agri. growth. Fertilizer is expected to contribute 64 to 75 percent of the total envisaged agriculture growth target of APP. APP has envisaged an increase in fertilizer usage from 31 kg nutrient/ hectare of the base year 1995 to 131 kg nutrient/ hectare by 2017.

The Agriculture Sector Performance Review (ASPR) survey carried out in 2000/01 estimated fertilizer usage to be 58 Kg nutrient/ hectare (ANZDEC, 2002). In another study conducted by Oxford Policy Management (OPM), UK in 2001-2002 for MOAC also estimated average application rate of 56 Kg nutrient/hectare (OPM, 2003). Table 1 shows the average fertilizer use per household to be 100.4 kg as suggested by the fertilizer use study 2002.

Table 1: Average Fertilizer Use per Household (kg / household)

Regions	Cereals	Cash crops	Pulses	Fruits	Vegetables	Total
Hills	21.3	11.8	0.1	0.0	2.7	35.9
Terai	137.5	14.7	6.2	2.0	3.9	164.3
Total	79.7	13.3	3.2	1.0	3.3	100.4

Source: Fertilizer Use Study, OPM, 2002.

The table also shows that fertilizer use in terai more than 4 times higher than that in the hills. The reasons are (a) ease of access (b) proximity to India, and (c) lower fertilizer prices that suggests the use of fertilizer is likely to increase with improvements in access to fertilizer (IDL Group, 2006). No other comprehensive survey on fertilizer usage has been conducted since then. However, the common sense dictates that the fertilizer usage is on the rise.

[1] Senior Agriculture Extension Officer, Ministry of Agriculture and Cooperatives

Fertilizer in Nepal has always been a political commodity. Supplying adequate quantity of fertilizer to the farmers in the country has always been a challenge for the governments. Governments have changed their fertilizer policies many times in a bid to ensure smooth supply of fertilizers in the country. Recently, the government has re-introduced subsidy on chemical fertilizers on cost sharing basis. This new subsidy policy is in implementation. This paper highlights the current subsidy policy and latter's implementation status. Moreover, the paper also presents overview of fertilizer policy development in Nepal over the years.

FERTILIZER POLICY DEVELOPMENT IN NEPAL

Fertilizer sector development and policy intervention in Nepal can be broadly divided into three phases as discussed below:

PHASE I -BEFORE 1973

Fertilizer was introduced in Nepal in early fifties with some private traders importing small quantity of Ammonium Sulphate (AS) from India. This was followed by National Trading Limited importing AS from Russia up to the mid sixties. Until then the level of fertilizer use was quite low.

Systematic efforts of importation and distribution of fertilizers started with the establishment of Agriculture Input Corporation (AIC) under then Ministry of Agriculture in 1966. AIC, as a public sector enterprise, was responsible for procurement and distribution of chemical fertilizers in the country. Initially, it imported fertilizers from India. Later on, it started importing fertilizers from international market. After the introduction of AIC in fertilizer business, demand for and use of fertilizer started to increase. Until 1972, cost plus basis of price was adopted. With that concept price of fertilizers in the hills would be fixed higher than that of terai for obvious reason of the transportation costs to be incurred while transporting fertilizers to the hills. Later, with the increase in price in international market, the policy was slightly altered to adopt uniform pricing system. With this pricing system hills farmers would get fertilizers below the actual cost whereas the farmers in terai region would pay more than the actual cost to offset the cost of transportation.

PHASE II- SUBSIDY REGIME FROM 1973/74 TO 1996/97

With the rise in the price of fertilizers in the international market, the government decided to introduce price subsidy, and transport subsidy in selected high hills and mid-hills districts in 1973/74. The subsidy policy was brought in to serve two purposes; first, encourage farmers to use fertilizers by providing at relatively low price, and second, discourage outflow of fertilizers from Nepal to India by keeping price 15-20 percent higher than that of India. AIC would get the difference amount between the actual cost and selling price. With the growing demand for fertilizer within the country and continuous rise in price of fertilizers in the international market, then governments were forced to bear huge financial burden as subsidy allocation. Since the fertilizers in Nepal are considered as politically sensitive commodity, no government would bother to make price adjustment to reduce the burden of exchequer. This situation aggravated AIC's loss to the tune of 850 million rupees at one time as the governments continuously became unable to allocate adequate budget to meet the subsidy requirement. AIC became unable to import fertilizers as per the demand for resulting short supply. Farmers were seen queuing up in the retail outlets of AIC to buy a meager quantity of fertilizer.

Nepal started receiving fertilizers under grant aid from the countries like Germany, Canada, Japan and Finland in late sixties. Some countries stopped the supply after 1991/92, while others reduced the volume. The supply used to be substantial in early years but became only a small fraction of total import in recent years. The latest such support came under 2 KR Grant Aid from the Government of Japan in 2006 in which 5412 metric tons of Urea was received.

PHASE III- DEREGULATION OF FERTILIZER TRADE FROM 1997/98 TO 2007/08

AIC, as a public sector enterprise, enjoyed monopoly in fertilizer trade for long time before the government decide to deregulate the fertilizer trade in 1997/98. There was full control of AIC in procurement and distribution of fertilizers. Sales price of fertilizers were regulated by the government. With the growing demand for fertilizer and rise in the price of the same, government failed to make adequate subsidy allocation. Subsequently, import and supply of fertilizers declined adversely affecting agriculture production.

Also prompted by ADB's loan condition for Second Agriculture Production Loan (SAPL), the government started deregulating the fertilizer trade in November 1997 with complete removal of subsidy in Diammonium Phosphate (DAP) and Muriate of Potash (MOP), and phase-wise removal of subsidy in Urea. The subsidy was completely removed after November 1999. The deregulation package involved: i) removal of monopoly of the AIC in fertilizer trade by allowing the private sector to import and distribute the fertilizers with equal treatment for both the parties, ii) time-bound phase out of fertilizer subsidies and iii) decontrolling fertilizer price.

Pursuant to fertilizer deregulation policy, Ministry of Agriculture and Cooperatives (MOAC) issued working policy to involve the private sector in the fertilizer trade. This policy paved way for private traders to stand at equal footing with AIC. To institutionalize the deregulation policy, and to regulate the business under the policy, the government promulgated Fertilizer Control Order, 1999 as per the Essential Commodity (Control) ACT, 1996. In line with the deregulation policy, National Fertilizer Policy, 2002 was formulated. Moreover, AIC was terminated to form two companies- 1) Agriculture Input Company Limited (AICL) responsible for fertilizer business and 2) National Seed Company Limited (NSCL) responsible for seed business - under the Company Act, 1996.

FERTILIZER CONTROL ORDER 1999

The main objective of Fertilizer Control Order (FCO) is to ensure quality of fertilizer supplied to the farmers with following salient features in it.

- quality control mechanism during import
- any legally registered private business firm can enter into fertilizer business
- quality control at retail level
- provision of fertilizer inspector for quality check
- quality control in production of fertilizer

NATIONAL FERTILIZER POLICY 2002

Objectives of the National Fertilizer Policy (NFP) 2002 are-

- provision of condition (policy and infrastructure management) for enhancing fertilizer consumption
- promotion of integrated plant nutrient management system (IPNS) for the efficient and balanced use of fertilizers.

and its salient features have been-

- broad definition of fertilizer to include three types of fertilizer- organic, chemical and microbial
- promotion of IPNMS to maintain soil fertility through minimizing soil degradation and likely negative impact of chemical fertilizer
- equal treatment to government, private and cooperatives firms involved in fertilizer business

- elimination of price subsidy but continuation of transport subsidy for selected districts of high hills and mid hills
- provision of buffer stock to respond to the acute shortage of fertilizer during the main cropping season
- policy of encouraging domestic production of fertilizer and provision of making investment in fertilizer industries of neighboring countries.

After the government adopted fertilizer deregulation policy in 1997, supply from formal sources (AICL and private importers) improved only up to 1998/99. The reasons behind were retention of partial subsidy in Urea import before November 1999, and relatively favorable price structure prevailing in the international market. Supply, however, went down after 1999/2000 onwards as both AICL and private importers could not import big volume owing to price fluctuation in the overseas market. Moreover, both the parties had hard times in selling fertilizers as subsidized cheap Indian fertilizers and, other adulterated and substandard fertilizers were easily available in the free markets of accessible areas. Farmers did not bother checking quality of fertilizers as they were happy to receive fertilizers at much lower price than that of AICL and authorized private importers. In addition to that, overall supply situation in remote areas could not improve for the obvious reason of high cost of transportation. Thus, while supply situation could not be improved as was expected, widespread problems of fertilizer quality also surfaced. This situation prompted to revisit the deregulation policy to address the issues encountered.

FERTILIZER DEMAND AND SUPPLY

FERTILIZER DEMAND

Due to the lack of scientific system of projecting fertilizer demand it is difficult to estimate real demand.

of fertilizers in the country. Moreover, unofficial import of fertilizer from long-open border with India has also made it difficult to estimate fertilizer demand. Such informally traded fertilizers constitute major portion of fertilizers being used in Nepal. ASPR (2002) estimated about two-third of the total import of fertilizers in Nepal came from unofficial import from India (ANZDEC, 2002). Although it is not possible to maintain actual record of cross-border inflow of informally traded fertilizers, there is no sign of subside.

Table 2: Average annual growth percentage of fertilizer demand as per ASPR field survey report

	Urea	DAP	MOP	Overall
Annual Growth Percentage	16	20.2	19.9	18.2

Source : ANZDEC, 2002.

ASPR field survey conducted during 2000/01 estimated 18.2 percent annual growth of fertilizer demand in Nepal (Table 2). Table 3 shows the projected demand for the fertilizers for five years. The figure was based on the survey of few selected districts from the hills and terai. The annual growth percentage of fertilizer demand seems quite high. Moreover, it is hard to believe that growth percentage of Muriate of Potash (MOP) to be 19.9. In reality, demand for and use of MOP is far below than that of Urea and Diammonium Phosphate (DAP). No other such study has been conducted thereafter. So, it's not possible to triangulate the survey report. Fertilizer demand collected by the Ministry from the all 75 districts shows that there is a demand of 726 thousand metric tons of chemical fertilizer for the Nepalese fiscal year 2066/67.

Supply of fertilizers increased continuously until 1991/92 with exception in 1975/76. The year 1991/92 witnessed the highest sale with 185.8 thousand tons. Sales started declining after 1991/92 primarily due to insufficient subsidy allocation by the government thereby hampering the import by AIC. However, average annual growth of fertilizer sale remained 8.74 percent during the pre-deregulation phase (Table 4).

Table 3: Projected fertilizers demand (MT) as per ASPR growth percentage

FY	Urea	DAP	MOP	Total
2064/65	253051.04	164621.74	15986.67	433659.45
2065/66	293539.21	190961.22	18544.53	503044.96
2066/67	340505.48	221515.01	21511.66	583532.15
2067/68	394986.36	256957.41	24953.52	676897.29
2068/69	458184.17	298070.60	28946.09	785200.86

Table 4 : Sales of fertilizers before deregulation (,000 MT)

Year	Sale	Growth percentage	Year	Sale	Growth percentage
70/71	17.73		84/85	100.12	15.19
71/72	25.43	43.43	85/86	102.2	2.08
72/73	32.05	26.03	86/87	105.74	3.46
73/74	36.78	14.76	87/88	121.23	14.65
74/75	36.39	-1.06	88/89	131.95	8.84
75/76	31.13	-14.45	89/90	158.8	20.35
76/77	37.84	21.55	90/91	168.55	6.14
77/78	45.23	19.53	91/92	185.8	10.23
78/79	45.59	0.80	92/93	169.767	-8.63
79/80	50.29	10.31	93/94	148.413	-12.58
80/81	54.29	7.95	94/95	176.688	19.05
81/82	56.44	3.96	95/96	133.25	-24.58
82/83	73.73	30.63	96/97	122.223	-8.28
83/84	86.92	17.89	Average annual growth		8.74

Source: Agri. Input Supply Monitoring Section, MOAC

Table 5 : Sales of Fertilizers after Deregulation (,000 M.T)

Year	AICL	Private	Total	Growth rate
1997/98	91.178	17.55	108.73	
1998/99	88.35	68.477	156.83	44.24
1999/2000	71.46	76.727	148.19	-5.51
2000/01	45.22	101.145	146.37	-1.23
2001/02	39.358	101.408	140.77	-3.83
2002/03	70.746	103.636	174.38	23.88
2003/04	20.493	118.265	138.76	-20.43
2004/05	31.811	90.895	122.71	-11.57
2005/06	13.295	78.258	91.55	-25.39
2006/07	25.169	65.679	90.85	-0.77
2007/08	6.646	47.107	53.75	-40.83
2008/09	7.133	8.325	15.458	-71.13
Average annual growth				-10.23

Source: Agri. Input Supply Monitoring Section, MOAC

Even after the deregulation, supply situation could not improve. As shown in Table 5, total sales declined every year with some exception resulting negative average annual growth of 10.23 percent. The fall in supply after 1999 was mainly due to rise in price of fertilizer in international market and uncontrolled inflow of cheap Indian fertilizers. While supply from the formal sources saw steady decline, overall supply increased dramatically, thanks to unofficially imported fertilizers through porous Indo-Nepal border. Although it is not possible to make estimation of cross-border inflow of fertilizers, it is estimated to be two-third of the total supply volume. Agriculture Sector Performance Review (ASPR) estimated that out of the total import of 430 thousand tons of fertilizers in 2000/01, approximately 280 thousand tons was imported unofficially from India. Moreover, a couple of mixed fertilizer manufacturing plants have been established in the country in post deregulation phase. They consume, as the raw materials, ready-to-use fertilizers such as Urea, DAP, Super Phosphates imported from India and the third countries. These plants are contributing only small quantity of fertilizers to the total supply yet putting pressure to the already imported ready-to-use fertilizers in the country. On the other hand, increasing complaints from the farmers of such mixed fertilizers being sub-standard quality have questioned the need to promote such plants. In a nutshell, it can be said that change in fertilizer policy in 1997/98 did not improve supply situation as expected.

CURRENT POLICY ON FERTILIZER SUBSIDY

GENESIS OF CURRENT POLICY

Deregulation policy largely failed to bring desirable impact on improving supply situation and quality control of fertilizer. External factors such as rise in price in international market, heavy government subsidy being enjoyed by the Indian farmers, and uncontrolled inflow of illegally traded fertilizers aggravated the situation. Due to excessive rise in price small and marginal farmers could not afford quality fertilizers. Farmers were forced to use fertilizers of unknown quality available in the free market albeit at cheaper price.

Farmers' voices have been loud in recent years regarding assured supply and quality of fertilizers. Moreover, they are helpless before free inflow of cheap Indian agriculture products produced under heavy government subsidy. Our farmers are unable to compete with such products as they are operating with extremely adverse condition without any incentive to go for production. In many cases, they can hardly recover cost of production by selling their produces. The issue has also been raised by the politicians, civil society and other members of the society.

To address the issue of fertilizer sector, MOAC came up with the proposal to review the existing fertilizer policy in October 2008 with the objective of making fertilizer supply and distribution arrangement more effective. Accordingly, MOAC forwarded the proposal to Council of Ministers (COM) in November 2008. COM gave approval, in principle, to the proposal to provide support in chemical fertilizers targeting small and marginal farmers. As per the decision of the COM, MOAC and Ministry of Finance in the leadership of Secretaries of the respective ministries developed operational modality of the subsidy administration and submitted the same to the COM. The government finally endorsed the modality on March 25, 2009.

Salient features of government's latest decision on providing chemical fertilizers at subsidized rate

IMPORT AND SUPPLY:

- provision of fixing sales price at 20-25 percent higher than that of India for five import points – Biratnagar, Birgunj, Bhairahawa, Nepalgunj and Dhangadi.
- provision of a high level 'Subsidy Allocation Management Committee' under the chairmanship of Secretary at MOAC. The committee is mainly responsible for fixing sales price of the five import points.
- AICL will be the sole agency to import fertilizer to be distributed at subsidized rate.

- AICL will receive difference amount between actual cost price of importing fertilizers from outside the country, and the sales price at import points.
- retail price for farmers will be sales price at the import points plus transportation cost up to the delivery point.
- Annually 100 thousands metric tons of fertilizers will be imported under this scheme.

DISTRIBUTION :

- Subsidized fertilizers will be provided for technically required amount for three crops a year.
- Subsidized fertilizers will be available for up to 0.75 hectare in the hills and 4 hectare terai.
- Subsidized fertilizers will be sold through the offices of AICL, and cooperatives organizations and cooperative shops.
- 'Fertilizer Supply and Distribution Management Committee' headed by the Chief District Officer of the respective district will look after the affairs related to supply and distribution of subsidized fertilizers at the district level.

ON-GOING AND PIPELINE PROJECTS IN THE FERTILIZER SECTOR

- Grant Assistance for Nepal Government to Increase Food Production for Underprivileged Farmers: A Japanese Study Mission was fielded during October, 2009 in course of preparation for the possible grant aid to provide chemical fertilizers to Nepal during Japanese fiscal year 2009. The team consulted the concerned personnel from the government and non-government sectors dealing with fertilizers in the country. At the end of the Mission a Minute of Discussion was signed between the two governments. Recently, Government of Japan has approved grant amount of 490 million Japanese Yen for providing chemical fertilizers to Nepal under the aforesaid grant assistance during the Japanese fiscal year 2009. The Grant Agreement is due to be signed in March this year.
- FAO TA Aimed at Prescribing Sustainable Fertilizer Policy: A FAO TA Mission visited Nepal on December 2009 with a view to reviewing government's current fertilizer policy and latter's implementation. The report on findings of the Mission has already been made available to the Ministry. Besides making policy recommendations, the report also highlights the possible project ideas for the sustainable fertilizer sector development in the country. FAO has been learnt to negotiate the projects to be funded by the donor agencies in days to come.
- World Bank Supported Irrigation and Water Resource Management Project: This on-going project is supporting the cost of transporting fertilizers up to the Agriculture Service Centers located in various parts of a district with the objective of increasing food production in 23 food deficit hilly districts.

ISSUES AND CHALLENGES

Nepal has been facing problems in ensuring supply of quality fertilizer as per the farmers' demand since long before. Major issues and the challenges of the present day fertilizer sector are discussed below.

IMPORT/SUPPLY

- With the reintroduction of price subsidy on chemical fertilizers the private sector has virtually lost the level playing ground with AICL as the former is not entitled to import and distribute the subsidized fertilizers. Genuine private fertilizer importers/traders can not compete with the subsidized stuff and that with unofficially imported subsidized Indian fertilizers and other substandard fertilizers. This has jeopardized the government's earlier made commitment of involving private sector in fertilizer business, which was one of the major objectives of NFP, 2002.

- Subsidy is available for only 100 thousand metric tons, which is far less amount than the actual demand. Rest of the demand is being met through the unofficial import from India. Any change in Indian government gesture on regulating illegal cross-border trade would bring a shock to the internal fertilizer market.
- Meeting the peak season demand of fertilizers has been a challenge even after the reintroduction of subsidy. Import of fertilizers from India under IPP scheme and that through global tender normally takes 3 to 5 months hampering timely supply at the peak requirement time.

DISTRIBUTION

- It is quite cumbersome to administer the provision of providing subsidized fertilizers up to 4 ha and 0.75 ha of land in terai and hills respectively. Producing valid proof of the land ownership to get meager quantity sometimes may not be both feasible and economical. On the other hand, landless tenants are denied the entitlement of buying the subsidized fertilizer stuff.
- Only cooperatives can sell subsidized fertilizers as per the current subsidy policy. Since in most of the cases cooperatives are not operating in all parts of the districts, farmers from the areas, with no cooperatives operating, are either unable to enjoy the subsidized stuff or they are forced to make even up to two days walk to get the district headquarters or the nearest cooperatives to buy the subsidized fertilizers.
- Especially in the hilly districts, even if there are cooperatives operating, there are unable to purchase the fertilizers owing to their poor financial capacity resulting constrained supply in these districts.
- District based 'Fertilizer Supply and Distribution Management Committee' is responsible for managing affairs related to supply and distribution of subsidized fertilizers. Monitoring of supply and distribution is an important aspect. There is a need that the committee acts promptly to ensure free, fair and smooth supply and distribution of the fertilizer in the district. However, the committee is operating with no logistic supports whatsoever for its effective functioning thereby resulting poor monitoring of supply and distribution of the subsidized fertilizers in the district.

QUALITY CONTROL

- There is uncontrolled inflow of unofficially traded adulterated and substandard fertilizers from India. Some private traders are blamed to repack such low quality fertilizers to give popular brands like that of AICL and other Indian fertilizer company thereby cheating the farmers. This is a matter of grave concern, and checking this problem is one of the major challenges of the present day fertilizer sector. MOAC alone can not control such illegal transaction given the limited number of manpower, that too, operating with only little legal and technical expertise, and that with poor logistic facilities.
- Import and distribution of organic and bio-fertilizers both in solid and liquid forms has been seen growing in an unprecedented manner in recent days. FCO, 1999 and NFP 2002 do not have sufficient provisions to regulate the import and distribution of such fertilizers.

USAGE

- Majority of the farmers are inclined towards using only nitrogenous fertilizers like Urea or they are disproportionately using N, P and K fertilizers mainly due to relatively low price of Urea and ignorance about the balanced use of fertilizers. The excessive use of nitrogenous fertilizers and unbalanced nutrient supply has increased soil acidity and deterioration of soil physical condition. Excessive use of nitrogenous fertilizer is also responsible for deterioration of underground water quality.

- Excessive use of nitrogenous fertilizers is also responsible for increased emission of nitrous oxide, one of the major gases responsible for global warming, and resultant effect on climate change.

DATABASE MANAGEMENT

- Lack of any mechanism to estimate total fertilizer requirement of the country based on crop requirement.
- Difficult to project demand for fertilizer in the country mainly due to prevailing unofficial import from India through cross-border illegal trade.

CONCLUSION

Chemical fertilizer is an important input for agriculture production. Nepal does not produce any fertilizers, so it has to depend on import from India and third countries. Fertilizer has been a commodity of political importance in Nepal for long time now. Often, the government is in pressure of dealing with farmers' demand for timely supply of quality fertilizers.

Changes in fertilizer policy over the time have produced mixed results. In the past, when there was subsidy on chemical fertilizer, relatively good quality stuff was supplied, but the supply was constrained mainly due to inadequate budgetary allocations. On the other hand, when deregulation of fertilizer was practiced and subsidy was lifted, supply situation performed relatively better but then issues of quality surfaced. Moreover, overall fertilizer trade and supply has been heavily influenced by the price in the international market, and illegal import of subsidized and other substandard fertilizers from India.

Despite the changes in fertilizer policy time and again, large fraction of fertilizer demand is still being met through the unofficially imported fertilizers from India. The situation is expected to continue until India takes policy of stern border regulation. That very day, Nepal would fall into an unprecedented crisis of supplying fertilizers to its farmers. To overcome such situation, voices are often heard as why not to establish fertilizer factory within the country. However, studies in the past suggested that establishing fertilizer plant in the country is not feasible. Thapa (2006) cited three main reasons for. Firstly, Nepal has no raw feed stocks or materials such as naptha, petroleum, coal, natural gas, phosphates or potash minerals. Secondly, electric power in Nepal is very costly as compared to the neighbours. Finally, the size of domestic demand is very small compared to an economic size of the fertilizer plant. Government's recently announced policy has come as a positive development in supporting farmers. However, given the amount of fertilizers to be provided in subsidized rate, problem of supply seems to remain in days to come.

RECOMMENDATION

Based on present day issues of fertilizer sector mentioned above and conclusion drawn, the following recommendation are made:

- If the government recent policy of subsidizing fertilizers is to continue, subsidy amount should be allocated for at least 300 thousand tons. Moreover, it is better to fix the allocation ceiling for subsidy rather than fixing the supply volume (100 thousand tons at present),
- There should be provision of fixing selling price of import points up to around 50% of the Indian retail price. This provision, on the one hand will improve supply situation.

On the other hand, it will reduce the burden of exchequer. Moreover, there should be flexibility to fix the selling price of import points based on type of fertilizers and pre specified crops,

- Government should engage in negotiation with Indian government to cease the all time problem of fertilizers by entering into agreement that ensures smooth supply from India. Negotiation should also consider the possibility of Nepal government receiving subsidized fertilizers from the Indian counterpart,
- Possibility of making share investment in new fertilizer factories to be established in neighboring countries like India and Bangladesh should be explored without further delay,
- Subsidy in urea may be lifted or heavily curtailed down. Urea is comparatively cheaper than other fertilizers and no further promotion is needed to increase the use of the same. This would also encourage the farmers to make balanced use of NPK fertilizers,
- IPNMS should be aggressively introduced in the farming system through the agriculture extension system. Special campaign for compost preparation and use is need of the hour,
- Production and use of organic fertilizer should be encouraged and promoted. (Govt. has allocated 50 millions for the promotion of organic fertilizers and establishment of organic fertilizer factory for the FY 2066/67),
- Implement the fertilizer buffer stock provision as envisaged in NFP,
- Strengthen Agriculture Input Supply Monitoring Section of MOAC to play more effective roles in changed policy context,
- Infrastructural and institutional strengthening of AICL is quite necessary to ensure smooth import and distribution of the fertilizers in the country. Additional outlets should be opened in the areas with reliable road networks to satisfy the demand of needy farmers,
- Government should also mull over the possibility of involving Salt Trading Corporation Limited if former is to increase the volume of subsidy more than 200 thousand metric tons as AICL is seemed to be able to administer 200 thousand metric tons at the most given the present organizational capacity,
- District Agriculture Development Offices and Fertilizer Inspector should be provided with all the needed legal, technical and logistic services and facilities for the effective monitoring of fertilizer quality,
- A comprehensive and coordinated policy and program should be formulated and implemented to address the quality issues of fertilizer, and
- MOAC should develop a visionary plan to address the issues of fertilizer sector and ensure supply of quality fertilizer in the country.
- With rapid expansion of fertilizer trade in terms of diversified products and increased volume of transaction, malpractices and quality issues have been widespread. So, it is high time to regulate the sector through appropriate statutory arrangement.

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Annex 1: Fertilizer Import by Source in the Last Ten Years (Metric tons) (1998/99 - 2008/09)

Year	Name of Fertilizer	AICL	Private	2KR (Japan's Aid)	Other donors	Total
1998/99	Urea	77857	91049		0	168906
	DAP	50132				50132
	MOP					
	Ammonium Sulphate					
	Others					
	Total (MT)	127989	91049			219038
1999/2000	Urea	30000	61347	7000		98347
	DAP	10000	31173	14817		55990
	MOP					0
	Ammonium Sulphate			1500		1500
	Others					0
	Total (MT)	40000	92520	23317	0	155837
2000/01	Urea	24189	76354	11820		112363
	DAP	30415	12365	10920		53700
	MOP			5140		5140
	Ammonium Sulphate					0
	Others					0
	Total (MT)	54604	88719	27880		171203
2001/02	Urea		79350	16220		95570
	DAP	12500	21004	13820		47324
	MOP			4300		4300
	Ammonium Sulphate		3000			3000
	Others					0
	Total (MT)	12500	103354	34340		150194

Year	Name of Fertilizer	AICL	Private	2KR (Japan's Aid)	Other donors	Total
2002/03	Urea		45190	17830		63020
	DAP		28187	10255		38442
	MOP					0
	Ammonium Sulphate		6662			6662
	SSP		3400			3400
	Total (MT)	0	83439	28085		111524
2003/04	Urea	4134	96146	7715		107995
	DAP	7000	29399	9500		45899
	MOP		1100			1100
	Ammonium Sulphate		4639			4639
	SSP		1498			1498
	NPK (12:32:16)		500			500
	APS (20:20:0:13)		4666			4666
	Total (MT)	11134	137948	17215		166297
2004/5	Urea	5370	17161			22531
	DAP	12081	30726			42807
	MOP		135			135
	Ammonium Sulphate		4689			4689
	Others		12247			12247
	Total (MT)	17451	64958			82409
2005/6	Urea	0	35385	6877		42262
	DAP	0	25585			25585
	MOP	0				0
	Ammonium Sulphate	0	6475			6475
	Others	0	25343			25343
	Total (MT)	0	92788	6877	0	99665
2006/7	Urea	14762	8467	5440		28669
	DAP	9362	3914			13276
	MOP					0
	Ammonium Sulphate		2374			2374
	Others	13880	27134			41014
	Total (MT)	38004	41889	5440	0	85333
2007/8	Urea	4891	2256			7147
	DAP		719			719
	MOP					0
	Ammonium Sulphate		9978			9978
	Others		24765			24765
	Total (MT)	4891	37718	0	0	42609
2008/9	Urea	4998.95				4998.95
	DAP					0
	MOP					0
	Ammonium Sulphate		2744.4			2744.4
	Others	2497.1				2497.1
	Total (MT)	7496.05	2744.4	0	0	10240.45

AGRICULTURAL POLICY REVIEW FOR COFFEE PROMOTION IN NEPAL

Kul Prasad Tiwari, MSc.[1]

ABSTRACT

Coffee is one of the important cash generative crops in the mid hills of Nepal. Coffee, being an important high value crops, is mostly grown in marginal areas with minimum use of improved technologies. In line with the focus of agricultural policies, the concerned organizations have not taken adequate initiatives for the promotion of coffee cultivation. In Nepal majority of coffee is wet processed, which is considered best method for good quality coffee. However, there is lack of updated manpower and improved technologies to work in this regard. As a result of which, quality of Nepalese coffee is below international standard. Around 65 percent of Nepalese coffee is exported and the rest amount is processed and supplied in the domestic market. Majority of coffee is exported through personal contact of traders rather than institutionalized marketing channel. Therefore, there is gap between what policies have stated and what actually implemented in the real fields for the promotion of coffee.

Key words: Agricultural policies, production, processing and marketing of coffee.

INTRODUCTION

Coffee is one of the important cash generative crops in the mid hill regions of Nepal (Gautam and Dhakal, 1994). Historically, it is believed that a saint named Hira Giri in Aanpchaur, Gulmi district, introduced coffee for the first time in Nepal from Myanmar in 1944 (Bastola, 2007). Initially, coffee spread to several districts through the initiation of individual farmers as well as by an ADB/N supported programs. From the mid-seventies, coffee was grown as a commercial crop. During mid-eighties, the coffee production in some districts was quite high. However, during late eighties marketing problems and poor returns from the crop forced many farmers to cut down their mature trees (Shrestha, 2004 as cited by Bastola, 2007).

Presently, coffee is cultivated in around 40 districts, but it has been producing commercially in about 20-22 hill districts. In Nepal, coffee is predominately grown by resource poor and small scale farmers under marginal upland condition (Shrestha et al., 2008) and mostly they don't use chemical fertilizers and pesticides in the production process. In most of cases, coffee_cultivation is using unproductive, fallow and the lands prone to degradation and thus it helps to conserve soil erosion, degradation of land and also provides 20-25 percent extra income than traditional cereal crops like maize and millet (Chaudhari et al., 2008). Coffee cultivation has an enormous potential to provide farmers a good employment and income generation opportunities especially in the mid-hills regions where there is a huge amount of land and suitable climatic condition for growing the coffee successfully.

In Nepal, coffee was initially known as the drink of the foreigners, tourists and expatriate, but nowadays, it has become popular among the Nepalese and therefore has received numbers of domestic consumers (Shrestha, 2004 as cited by Bastola, 2007).

In terms of area coverage and production, Nepalese coffee has tiny presence in comparison with the world production and area. However, Nepalese highland and organic coffee is known in the international markets owing to its high quality cupping and sound aroma (Poudel et al., 2009). Especially Nepalese coffee has high demand in Japan, America, South Korea, Germany and the Netherlands. However, in comparison with demand in the

[1] Agricultural Extension Officer, Ph. 9849362037, Email: tiwarikp@hotmail.com

international market, Nepalese coffee has low production and below the standard quality specified by the developed countries.

Most of the coffee grown in Nepal is considered organic as coffee is grown in the natural condition and most of the farmers do not use chemical fertilizers and pesticides during cultivation and processing. There has been growing interests from both government and non-government sectors for promoting organic coffee and farmers are also motivated to produce coffee owing to higher demand in the international market.

Considering the importance of high value crops including coffee and with the view of expanding the production and productivity, government has promulgated several agricultural policies, strategies and guidelines for the promotion of production, processing and marketing of high value crops. For instance, the Coffee Policy 2004 was promulgated with an aim of fostering production and marketing of coffee.

In this context of emerging coffee as a valuable commodity, it is worthwhile to evaluate the focus and implication status of agricultural policies for promoting the production, processing and marketing of coffee in the country.

OBJECTIVES

The main focus of this study is to analyze the content and implication status of agricultural policies, strategies and guidelines for strengthening the production, processing and marketing of coffee in the domestic as well as international market. Specifically, the objectives of this study are as follows:

1. To review agricultural policies for promoting the production, processing and marketing of coffee,
2. To analyze the implication status of agricultural policies for promoting coffee business.

METHODOLOGY

The research is of exploratory type and the sources of data are primary as well as secondary. For gathering the relevant information for this study, the interviews were conducted with policy makers, farmers involved in coffee production, coffee processors and traders who are involved in the trading and marketing of coffee.

For the secondary data, papers published in different journals, technical books and annual publications, policy review and impact studies etc were used. Specifically the analyzed policies for this study were: Coffee Policy 2004, Periodic Plans: 9th and 10th Five Year Plan, Three Year Interim Plan (2007-10), Agriculture Perspective Plan (APP), Three Year Strategies Plan of Coffee, National Agriculture Policy 2005, Nepal Agri-Business Promotion Policy 2007 and Implementation Strategies 2009, Biodiversity Policy 2006, Coffee Policy 2004, Impact Evaluation of APP 2007 etc.

REVIEW OF AGRICULTURAL POLICIES

Some of the policies have special focus on promotion of coffee. These policies with their focus have been mentioned in the following paragraphs.

AGRICULTURE PERSPECTIVE PLAN (APP)

The APP (1994/95-2014/15) is long term strategic policy for accelerating agricultural growth by increasing the factor productivity, transforming the subsistence based agriculture into commercial one by strengthening the production pockets, reducing poverty by providing the employment opportunities and promoting the involvement of private sectors in the development of agriculture. One of the prioritized outputs of APP is to promote high value crops. For this it has prioritized different crops for different ecological zones of the country including Terai, mid hill and high hills. For instance, high hill for apple, mid hills for citrus, nevertheless, coffee has not recognized as a high value crop for the mid hill region of Nepal by APP though it has great scope of expanding in the mid hill regions. The huge marginal landscape of mid hills, which are prone to depredate and marginal, can be tapped for the commercial production of coffee. The APP emphasize paradigm shift from subsistence oriented farming to market oriented farming through a land use system based upon sound ecological principles and conducive agricultural policies. Though APP has not focused especially coffee as one the high value crops, the subsequent agricultural policies and strategies have paved the way for the promotion of coffee as high value and exportable commodity.

PERIODIC PLANS

The Nineth (1997-2002) and the Tenth (2002-2007) Five Year Plans have focused to increase production and productivity of high value crops for poverty reduction and protection and promotion of agricultural biodiversity and environment (NPC, 2002). For the first time Nineth plan prioritized promotion of coffee plantation to fulfill the long term strategic plan of APP (NPC, 1997). The Tenth Plan had also targeted to increase the production of coffee but strong emphasis has not been given for import substitution and promoting the export of coffee. The Tenth Plan has focused on production support on coffee and started to give 50% subsidy on the sampling of coffee to the farmers (NPC, 2002). However, the Nineth and Tenth Plans could not pave the way for large scale production of coffee considering its commercial importance and speciality in the marginal areas of mid hill regions. In line with the Agriculture Perspective Plan (1994/95-2014/15), the Ninth Plan initiated the Pocket Package Approach (PPA) for the different agricultural commodities, however, the production pockets for the coffee was not specified. Additionally, the Ninth and Tenth has not given importance for the promotion of organic agriculture adequately.

THREE YEAR INTERIM PLAN (2007-2010)

The Three Year Interim Plan (2007-2010) came with the focus of transforming subsistence based farming into commercial one and conserving, protecting and utilizing agricultural biodiversities via development and dissemination of environmentally friendly technologies. This reveals that this plan has apparently given significance to the organic production of high value crops. Realizing the potentiality and emerging role of coffee on the national income and improving farmers' income, this plan has included the coffee, among other 22 valuable commodities, as a priority commodity and fixed target of 685 MT from the base year of 360 MT. The Three Year Plan emphasized mid hill areas for the promotion of coffee production (NPC, 2007).

NATIONAL AGRICULTURAL POLICY (NAP) 2006

The NAP came as a main document to provide clear direction for the development of agriculture sector in line with APP and to specify major promotional areas of agriculture sector. The NAP's main objectified areas are to commercialize agricultural commodities based on comparative advantage and speciality of geographical setting to make agricultural products more competitive in the regional and international markets and to conserve and promote the natural resources, agro-biodiversity and environment (MOAC, 2006). The NAP strategically prioritized the areas having specific potentiality for promoting the high value commodities in order to get higher return. The NAP has stressed over the use of the upland and marginal public and private lands for commercial production of high value crops and such stipulated areas could be apt for growing coffee especially of organic one. In the context most of the coffee is grown organically, this policy can be said has spotlighted significantly for fostering coffee as high value crops in the mid hill regions. However, the coffee has not got high focus in comparison with other high value agricultural commodities.

COFFEE POLICY 2004

The coffee policy has formulated to pave the way for involving the private sectors, NGOs, cooperatives and other members based organizations for promoting the production, processing and marketing of coffee in a sustainable and organized way. This policy came to bring momentum in the business of coffee in the context whereas other agricultural policies did not stress visibly for the promotion of coffee. The emphasis of coffee policy is to substitute the import and promote the export of coffee expanding area under coffee production and finally to conserve the ecological environment of mid hills area (MOAC, 2004). This policy has focused on developing the modern technologies for the production and processing of coffee with the active participation of government and private sectors. Importantly, the policy has also given priority to develop necessary manpower for promoting the production and processing of coffee; encouraging the manufacturing of necessary machines and equipments for the coffee processing within the country. Additionally, this policy stressed to coordinate with foreign countries consulates located in Nepal for exporting the coffee; messages about important of organic coffee and other promotional activities conducted and promoting the organic coffee production. Equally, this policy focuses to establish laboratory for improving the quality aspect of coffee; higher education and trainings and conducting the research for promoting production, processing and marketing of coffee. Nevertheless, this policy doesn't focus for the development of special pockets for organic coffee, which is paramount importance for the strengthening the organic coffee in the country.

AGRICULTURAL BIODIVERSITY POLICY-2007

The main point of this policy is to protect, promote and use of agricultural biodiversity for sustainable development of the agricultural sector and furthermore focused to conserve and promote traditional knowledge, skills and practices of farming. Therefore, this policy has undoubtedly emphasized for the promotion of organic production of high value agricultural products owing to its significance for biodiversity conservation and high demand in international market. With the center of attention of escalating the organic production, this policy can be said to have a strong promotional character for organic production like coffee and other crops (MOAC, 2006).

AGRI-BUSINESS PROMOTION POLICY (ABP)-2007

The ABPP is likely to contribute significantly towards the promotion and development of the high value crops developing commercial pocket areas based on the specialty and possibility of concerned areas. Though the concerned organizations (DOA, DADOs) have focused for the development of pockets of other high value crops, the center of attention of this policy isn't for establishing the production pockets of the coffee with view of the expanding its production and productivity with the additional support of necessary infrastructures. The ABPP further stresses on the demand lead training for promoting agri-business to increase knowledge and skills of the producers, processors and other activities of commercial production of the high value crops (MOAC, 2007). Moreover, this policy clearly mentioned about promotion and development of organic production zone to support and to increase the volume of organic production of agriculture commodities. Since most of the farmers are cultivating coffee without using the chemicals, this policy is highly positive for fostering organic coffee production. In the same way, ABPP also has stated to develop the organic certification of the organic products so as to provide legal guarantee of purity and to meet the international standard of the organic products.

NATIONAL TECHNICAL STANDARD FOR ORGANIC AGRICULTURE SYSTEM (NTSOAS) 2008

Of late, the government has promulgated National Technical Standard for Organic Agriculture System 2008, a specific guidelines for promoting organic cultivation. The NTSOAS is in line with the guidelines of IFOAM[2] and has focused on specific land arrangement for organic production; prohibits contamination of agrochemicals in crops production, processing and storage; limit the use of chemical fertilizers and un-decomposed organic matter and urban waste; protect farmers from getting fair prices from their agricultural products and to develop organic certification system. The NTSOAS has further cleared the way for promoting the organic production and processing of high value agricultural products.

IMPLICATION STATUS OF AGRICULTURAL POLICIES

COFFEE PRODUCTION

Even though most of the agricultural policies focused on promotion of high value crops, the area expansion and production of coffee has not increased adequately (see the table 1 for details). In the recent years, even the production of coffee is decreasing instead of increasing with escalating the areas under the coffee cultivation.

Table1. Area and production of coffee in Nepal in different Years

Particulars	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
Area (Ha)	424	596	764	925	1078	1285	1396	1450	1531
Production (Mt.)	88.7	139.2	187.5	217.6	249.8	300.4	460.2	276	267.6

Source: MOAC (2009)

Mostly the coffee producers grow the coffee in small scale with 100-150 plants. In some districts farmers have grown coffee in maximum of 6-8 ropani areas. This trend depicts that farmers are not ventured yet into large scale production of coffee. Besides area coverage and production, the productivity of Nepalese coffee is also comparatively low than the productivity of other countries. At present, the productivity of green bean is 300 Kg per hectare nonetheless; the productivity of coffee can go as high as up to 3,000 kg per hectare (AEC, 2006). Though most of the farmers don't use chemical inputs while cultivating the coffee, the production can't be said pure organic as most of coffee is not grown under strict supervision and specified guidelines of organic production system.

There are limited manpower/coffee experts for supporting the farmers for coffee cultivation. Normally, farmers don’t get required suggestions/advices from the concerned organizations about cultivation practices of coffee. However, in some cases District Coffee Producers Associations (DCPA), District Cooperative Association Union (DCAU) and village level farmers' cooperatives motivate the farmers for organic production of coffee because organic coffee has higher demand in the international markets and thus farmers can get higher prices than conventional products.

The trainings, which are considered crucial for providing the new knowledge and skills to the coffee farmers about the production, however, such supports, are provided inadequately. District Agriculture Development Offices (DADOs), Tea and Coffee Development Board (TCDB), National Coffee and Tea Development Programs (NCTDP) have responsibility of providing technical services to the coffee growers, have very limited programmes and support for promoting coffee cultivation in the country. Coffee related programs are not prioritized programs of the DADOs. Mostly the DADOs, district level

[2] International Forum for Organic Agriculture Management

government organizations, don't provide production inputs such samplings and fertilizers etc. However, farmers have established their own nurseries for the coffee samplings.

Some NGOs like Helvetas, is supporting the coffee farmers via Coffee Promotion Project (CoPP) in nine districts[1]. Its focus is on promotion of quality coffee production rather than area expansion of coffee and therefore CoPP has been helping farmers for promoting the organic coffee. However, its coverage and level of support is not sufficient to meet the need and requirement of majority of the farmers for wider expansion of coffee cultivation in the concerned districts.

CERTIFICATION OF COFFEE

Certification is particularly useful because it allows for consistency of characteristics, improves market transparency, provides marketplace credibility and captures the demand and price incentives of niche markets (Lewin et al. 2004, LYON, 2009). In Nepal certification for organic coffee is in rudimentary phase. From the government side, established mechanism has not developed yet for promoting the organic certification. However, Gender Equity and Environment Division (GEED) of MOAC has recently prepared National Technical Standard for Production and Processing of Organic Products for promoting organic production, processing and certification of organic products. National Coordination Committee for Organic Agriculture Processing System has also been established for facilitating this process.

NGOs especially Hevetas, Nepal Permaculture Group and some private organizations are catering the technological need of organic coffee producers to some extent. Nonetheless, the role of CoPP/Hevetas is appreciable for supporting organic methods of coffee production and inspection, certification and marketing. Considering the importance of organic coffee certification for the promotion of organic coffee production, CoPP has started (in 2005) Internal Control System (ICS[2]) in collaboration of District Cooperatives Federation, Gulmi for the certification of coffee. From the experiences of Gulmi, this system has also started in the Lalitpur district. The ICS is an aim of gaining experience on requirements of ICS, expenses needed for the system and identify cost effectiveness and sustainability and appropriateness of ICS in Nepal (CoPP/Helvetas, 2009).

In the organic production, certification process is expensive one in case of Nepal because only small amount of coffee has been produced so far and thus traders and companies are not actually ready for supporting in the certification process. International agencies such as National Association for Sustainable Agriculture, Australia (NASAA) (Australia) and Japanese Agriculture Standard (JAS) have involved in the certification of coffee. Aforesaid, only NASAA, an Australian organization is certifying the organic coffee especially of Gulmi district and have just started in the Lalitpur district. Thus small fraction of coffee is sold as certified organic coffee in the international market.

COFFEE PROCESSING

Processing method of coffee has great role for the quality coffee production. In Nepal generally two methods of processing are practiced namely, dry and wet processing. However, presently, most of coffee is wet processed in which farmers harvest ripe fresh cherries and sell to the pulping centres and then the cherries are pulped, fermented, washed and dried to produce dry parchment at the pulping center. Dry parchment is collected by processor/traders and hulled at the central processing unit to produce green beans (Shrestha, Sharma, and Mishra (2008) and then the green beans are exported.

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[1] Sindhuli, Kavre, Lalitpur, Kaski, Parbat, Syangja, Palpa and Gulmi.

[2] Local people are strengthened technically for inspecting, monitoring and evaluating the cultivation practices of coffee with regards to international guidelines for organic products. Times to time technical supports are provided from the NASAA.

But quality of coffee in wet processing rely on operational processes in the pulping centre and their management: quality of available water used in the pulping centre, types of pulping machine, fermentation duration, facilities available for drying, washing process, storage etc (CoPP/Helvetas, 2008). Basically, Producers' Association, Cooperative Union and private companies are involved in the final processing and packaging of coffee.

For working in line with agricultural policies (including coffee policy) and for processing and production of best quality of coffee, different government and non-government organizations have played significant role. The NTCDB and NCTDP provide pulping machines to the Coffee Producers Cooperatives and District Coffee Producers Associations (DCPAs) on 50% discount. However, due to increasing the business and involvement of even village level cooperatives in the pulping activities, there is high demand of pulping machines.

Besides distributing the pulpers, the NTCDB organizes training programs in coordination with DCPAs and Producers' cooperatives to the farmers and other persons who involve and can involve in the pulping and/or processing activities for improving the quality of coffee. Nonetheless, the numbers of trainings are very limited to strengthen the capacities of the farmers and other concerned persons in the business of processing. Because of low intensities of training concerning to processing and management, there are not adequate numbers of well trained persons either in cooperatives or in producers' associations. However, the NCTDP also doesn't provide adequate numbers of trainings so as to increase farmers' and processors' competencies for the processing of best quality coffee.

Though agricultural policies including the Coffee Policy have focused to develop modern technologies in the processing of high value crops, such improved technologies are not introduced and/or developed so far to support the processing of coffee. There are not adequate research activities for the generation of new technologies/or develop new practices in coffee processing. Moreover, there is not strong mechanism either in the government or nongovernment organizations to provide new technologies to the processors to improve processing practices and better off the quality of coffee. Additionally, as mentioned by the policies especially of coffee policy and Agribusiness Promotion Policies to promote the manufacturing of equipments and tools necessary of processing of coffee but such practice has not developed yet in Nepal. All required tools are imported from abroad and thus quality of processed coffee isn't uniform owing to varied sorts of processing machines.

MARKETING OF COFFEE

Market is vital aspect of coffee business for getting higher return. Among the different agricultural products produced and exported from Nepal, coffee is growing as a competitive one with 7.3% share of country's total of 15% agricultural export share (FAOSTAT/World Bank, 2006). Participation in international trade with the developed countries will offer great opportunities to Nepalese coffee. But, at the same time, quality obligatory for agricultural products set by these countries are very high that Nepal in many situations may fails to meet these criteria (Adhikari and Adhikari, 2005). In the world market, the demand of organic and highland coffee is high. Due to climatic peculiarity of mid hills of Nepal and thus the coffee produced in these regions have great scope in international markets.

At present, more than 65% of Nepalese coffee is exported especially to Japan, Europe and USA in the form of parchment by the coffee mills and 35% of the total product is processed and supplied in the domestic market (Gautam and et al, 2008). Nepal exports only super quality green bean to overseas markets. Medium and low quality green beans are roasted, grinded and sold in the domestic markets.

Generally, there are four value chains found in Coffee sub sector (Fig. 7).

Nevertheless, there are not established marketing channels for selling Nepalese coffee in the international market directly by producer cooperatives and District level producers associations. Majority of the coffee is exported in the international arenas through personal contact of the traders rather than institutionalized exporting mechanism. Thus there is no certainty of getting market and good prices of Nepalese coffee in the international market. Additionally, there is no transparency in the marketing of coffee: actual price of Nepalese coffee in the international markets is unknown to the producers, cooperatives and producers associations. The traders generally don't disclose the actual prices of Nepalese coffee in the international markets. This has created confusion among the producers.

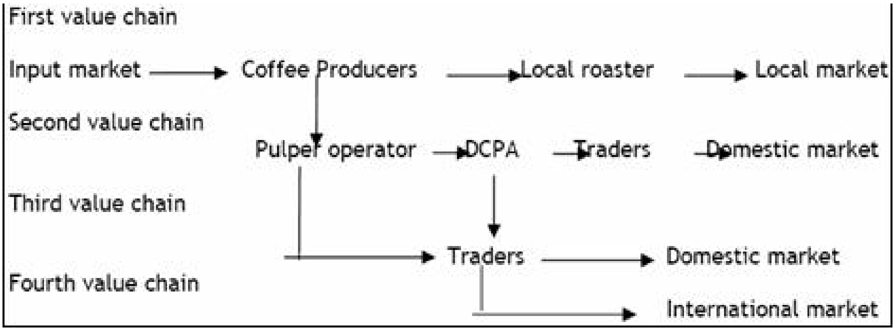

Fig. 7: Different value chains of coffee sub-sector.

In general Nepalese coffee is getting 3.5 times more price than Indian coffee in the world market due to high quality (Pathak, 2004 cited by Bastola, 2007). Nonetheless, market of Nepalese coffee is hitherto very limited because of lack of well developed marketing channels and low volume of production. In case of local market main constraints for the growth of Nepali coffee is due to lack of awareness about coffee among the local consumers. For fostering the marketing of coffee, the NTCDB organizes Coffee Day annually and provide information regarding the coffee to lure the domestic as well as foreign consumers'. The Coffee Day is organized especially for the promotion of marketing of coffee.

Nevertheless, so far limited activities have organized to promote the coffee in the international market by the government and nongovernment organizations. The production of coffee in Nepal is less than the quantity and quality demanded by traders, in this context, it is necessitated to escalate the productivity and quality of coffee in consideration with demand of international market.

Table 3: Export of coffee in different years

Years	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09
Quantity (Kg)	9075	16861	24295	65000	100180	112000	127000	88100
NRS (000)	2455	5205	5947	19662	40117	107800	114300	792900

(Source: AEC, 2009)

District Cooperative Federation, Gulmi is the only exporter of certified organic coffee (Certified from NASAA). It mainly exports to Japan and South Korea. Another effort to promote coffee export was done by Highland Coffee Promotion Company, Everest Coffee Company and Plantec Inc. to USA, Japan and Europe (Poudel and et al, 2009).

Though agricultural policies have focused for the strengthening the marketing of Nepalese coffee in the international market, the concerned government organizations have not been able for the promotion of export of coffee in the international market. This reveals that there is clear gap what is stated in the policies and what is actually implemented in the field. Apparently, there is lack of research on marketing of Nepalese.

CONCLUSION

Although most of agricultural policies have focused for increasing production and area coverage of high value crops like coffee, the area expansion and productivity is not expanding as expectation owing to several limiting factors: lack of sufficient motivation to the farmers, inadequate technical and material supports to the coffee producers, coffee is grown in the marginal area, producers don't adopt the improved cultivation practices, production pockets of coffee have not developed.

Certification is paramount importance for organic coffee but sufficient works has not been done in this regard. Actually, well established mechanism has not developed yet for the certification of organic coffee. However, international agencies such as NASAA, Australia and JAS, Japan are involved for certification of organic coffee in Gulmi and Lalitpur districts. Highland Coffee Promotion Company Limited has been able to certify organic coffee produced in the Palpa and Syangja districts.

In Nepal majority of coffee is wet processed and coffee processed by this method is considered good quality than dry processed method. Generally, cooperatives at the local level do preliminary processing (pulping, washing, fermenting etc) and prepare dry parchment. The DCPA do further processing and final processing is generally done by traders/trading companies at the central units. Due to lack of adequate well trained manpower and modern technologies, the quality of Nepalese coffee is not as demanded by the traders and international consumers.

At present, more than 65% of Nepalese coffee is exported especially to Japan, Europe and USA and 35% of the total product is processed and supplied in the domestic market. Nepal exports only super quality green bean to overseas markets. There are not established marketing channels for selling Nepalese coffee in the international market. Majority of the coffee is exported in the international arenas through personal contact of the traders rather than institutionalized exporting mechanism and thus there is uncertain market and reasonable price to the Nepalese coffee.

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IMPLEMENTING ABS REGIME IN NEPAL THROUGH COMMUNITY BASED BIODIVERSITY MANAGEMENT FRAMEWORK

Bikash Paudel, Pitambar Shrestha, Bir Bahadur Tamang and Abiskar Subedi

ABSTRACT

It is very evident that there is lack of well accepted and verified mechanisms as well as institutional set up for the realization of farmers' rights, including the effective implementation of International Regime on Access to and Benefit Sharing (IRABS). Community Biodiversity Management (CBM) embed good practices, proven to be effective in in-situ conservation of biodiversity through conservation through use, they also provide a base for a range of practices which serve the basis for IRABS to be affable and affordable to local communities. CBM encompasses the good practices serving documentation, conservation, facilitating exchange, providing access to genetic resources and associated traditional knowledge. Moreover, CBM also provide institutional structure and mechanism to share the benefits accruing from commercial use of the genetic resources, directly and indirectly.

Key words: Genetic resources, associated traditional knowledge, access and benefit sharing, farmers' rights, community biodiversity management

INTRODUCTION

The extreme variations in altitude, topography, climatic conditions, socio-cultural composition and farming practices have evolved immense diversity in natural flora and fauna as well as cultivated crop species in Nepal. Comprising of less than 0.1 per cent of earth's land mass, harbouring 10 % all birds (862 species), 4 % of all mammals (181 species), 1.53 % of all reptiles (143 species of reptiles and amphibians), 6 % of all bryophytes (687 species of algae), 3 % of all pteridophytes (1500 species of fungi and 465 species of lichen) and 2 % (around 7000 species) of flowering plants, hence stands 31st in world ranking in terms of biodiversity. Besides, about 200 species of commercially important medicinal and aromatic plants, 5000 species of insects, 185 species of fishes, 400 species of agro-horticultural crops, 60 species of wild edible fruits and 300 species of orchids (NBS, 2002; Gautam, 2008).

As a party to Convention on Biological Diversity (CBD), Nepal is obliged to recognise and implement provisions of protecting rights of local and indigenous communities over genetic resources while implementing access to and benefit sharing (ABS) regime. Being a member of the World Trade Organization (WTO), Nepal is committed to provide protection on plant varieties either by patents or by an effective *sui generis* system or by any combination thereof. In the other hand, after ratification of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Nepal is committed to take appropriate measures to protect Farmers' Rights over Genetic Resources and Associated Traditional Knowledge (GR and ATK). All these international commitments, are closely associated with the Nepalese agriculture since these provisions alter the ways of providing access to genetic resources, protecting the Intellectual Property Rights (IPR) of the "novel" seed as well as other technology and respecting the traditional and cultural rights of the farmers on the GR and ATK.

Although, the provisions of ABS, IPR and Farmers' Rights are to be implemented in Nepal through national legislations, none of the commitments have been reflected in any legislation. Embracing "National Biodiversity Strategy – 2002" and preparation of draft law on "Access to Genetic Resources and Benefit Sharing – 2002" are the major steps taken by Ministry of Forest and Soil Conservation (MoFSC) to abide the commitments of CBD (MoFSC, 2002). Ministry of Agriculture and Cooperative has also finalized “National Agro biodiversity Policy- 2007” (MoAC, 2007), prepared draft law on “Protection of Plant Varieties and Farmers' Rights - 2007” for ensuring Farmers’ Rights while implementing IPR regime (MoAC, 2008).

Although, the International Regime on Access and Benefit-Sharing (IRABS) is a global legal instrument, the provisions of the Convention on Biological Diversity (CBD) and Bonn Guidelines show implementation of the regime starts from local communities. While an international instrument for regulating ABS is required to generate the incentive for conservation of rapidly depleting biodiversity, the execution should effectively guarantee the recognition of the local communities and indigenous people as the true custodian of the GR and ATK, and their right to make decisions on documentation, conservation, development and sustainable use and access and benefit sharing. Environmental laws are most likely to generate local environmental and social benefits when indigenous peoples and local communities have the right of free, prior and informed consent over any activities undertaken on their lands or regarding access to their traditional knowledge, innovation and practices (TKIP)(Bavikatte and Jonas, 2009).

It is apparent that the impact of an International Regime on ABS (IRABS) on local and indigenous communities will only be possible when effective and innovative mechanisms, serving as the basis for implementing IRABS in communities and appropriate institutional development among the custodians of GT and ATK, are identified, legitimated and promoted. But, it is very evident that there is lack of well accepted and verified mechanisms as well as institutional set up for the realization of farmers' rights, including the sharing of the benefits arising from the use of GR and ATK.

There have been some of the good practices in community level, like Community Biodiversity Register (CBR), Community Seed Bank (CSB), Adding Value and Marketing of genetic resources, Participatory Plant Breeding (PPB) and Participatory Varietal Selection (PVS), Community Based Seed Production (CBSP) which have been very successful tools for conservation of the local genetic resources through use. All these good practices of previous works have been embedded in the name of Community Biodiversity Management (CBM) framework. There are enough possibilities that some of these tools and approaches could serve the basis for making IRABS to be affable and affordable to local communities.

OBJECTIVE

The overall objective of the study was to assess the mechanisms which could be the basis for implementing Farmers’ Rights through fair access to and benefit sharing from the use of genetic resources and associated knowledge in Nepal. The specific objective of the study was to assess the opportunities provided by CBM framework for implementation of International Regime on Access to and Benefit Sharing (IRABS) in Nepal.

METHODOLOGY

The study was an action research initiative with broad range of the activities in community, district and national level. Major part of the initiative was to implement the possible mechanisms (which could serve the basis for implementing IRABS in different type of communities in Nepal and with different type of genetic resources) and study whether that could serve as the basis for implementing IRABS. The data were gathered during a period from 2008 to 2010 from Rupakot (Kaski), Jogimara (Dhading), Bachauli (Chitwan), Kachorwa (Bara) and Tamaphok (Sankhuwasabha). The information on processes, product and effect of implementing Community Biodiversity Register, Community Seed Bank, PPB and PVS, CBSP, CBM Fund, Biodiversity Fairs were gathered separately from both qualitative and quantitative research methods as appropriate. Different studies to assess the effectiveness of the mechanism to implement IRABS were also conducted, by gathering the data from randomly sampled respondents and also by using different PRA tools.

Review of the previous literatures on good practices of in-situ conservation, Community Biodiversity Management and Community Biodiversity Register (CBR) has been a very important part of the research method. The paper includes review of the previous findings on a specific good practice, which provide base for the hypothesis that the mechanism could serve the IRABS to reach the community and provides some more justification based on the data gathered.

CBM FRAMEWORK

Community-based Biodiversity Management (CBM) is a participatory approach to empower farmers, farming communities, and local institutions in managing biodiversity for social, economic and environmental benefits to the community, as well as to the general public (Subedi et al., 2006). CBM embed good practices, proven to be effective in in-situ conservation of biodiversity in a brawny framework which is effective to empower the communities to control over the local genetic resources and take benefit from them.

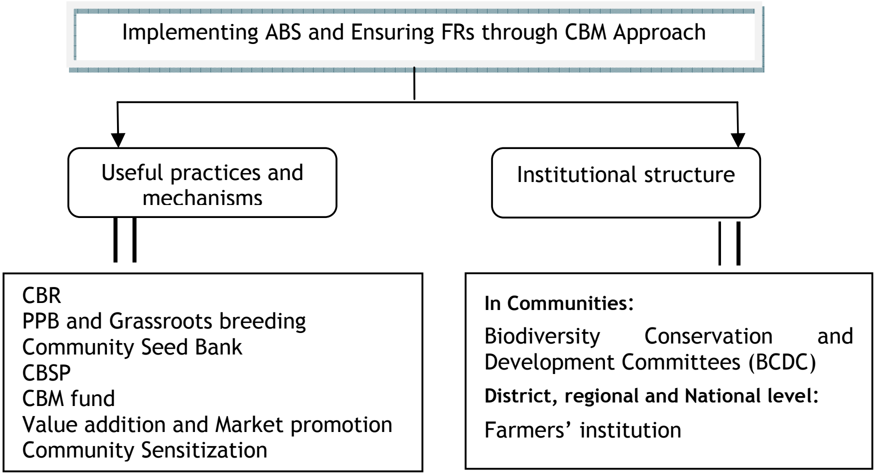

Fig. 1: CBM framework as a basis for implementing ABS Regime and ensuring FRs

Regarding documentation sharing and conservation of genetic resources and ATK, CBM framework embed participatory tools like CBR, diversity fair and Community Seed Bank. It also accommodates a range of practices like PPB, PVS and grass-root breeding for adding value to the local genetic resources through breeding process and linking the products of marvelous local genetic resources to the noble market. CBM frame accommodates the practices of strengthening local seed system and promotes farmer as producer as well as user of seed through CBSP.

To implement all the functions on management of biodiversity CBM framework also includes the structural part of activity. Biodiversity Conservation and Development Committees (BCDCs) is a model of organizing the custodians of the genetic resources which, CBM framework is promoting.

CBM PRACTICES SERVING AS A BASIS FOR IMPLEMENTING ABS

Best practices in community level, previously found to be useful in conservation of the local GR on farm (Sthapit et al., 2008), has also been verified as mechanisms to serve the basis for ensuring FR and implementing ABS regime. Some mechanisms have more evident functions in the process of implementing ABS; whereas some of them only contribute in the process. The tools attributing to documentation of biological diversity and ATK, empowering local communities for making decision on conservation and use, adding value to them to generate direct incentive would be essential in the process of ABS. Likely, tools supporting exchange of genetic materials and ATK and ensuring effective PIC of custodians on the process of access are also very much essential. Although, monitoring commercial use of GR and ATK and ensuring the sharing of the benefit are essentially not the function of communities, but fair and equitable distribution of the benefits that has been shared needs strong community roles. CBM encompass different tools for documenting biodiversity and ATK, empowering communities to take decisions on their management, adding value to them to generate sustainable direct benefits, share GR and ATK in a way that community will not lose their custodianship, deciding PIC in the process of providing access and sharing the benefit accruing from the commercial use. The framework of CBM also empowers communities to understand the legal and policy content in the management of genetic resources. All these best practices and their role in the process of implementing IRABS into the communities are discussed in the following chapters.

DOCUMENTATION OF THE BIODIVERSITY AND ATK

Community Biodiversity Register (CBR) is a record, kept in a register by community members, of the genetic resources in a community, including information on their custodians, passport data, agro-ecology, cultural and use values' (Sthapit et al., 2001). Under the condition that CBR is recognized in the policy and legal frameworks as the certificate of the custodians of GR and ATK, it will facilitate the process of bio-prospecting, provide the basis for the ownership (Gauchan et al., 2005) and specify communities to gain PIC while providing access. Moreover, CBR will be the base for the information to be published for effective use of defensive publication, which is believed to restrict any future IPR claim on our local GR and ATK.

Analyzing different institutional structures viz. member based CBOs, Community Forest User Groups (CFUGs), Cooperatives and Biodiversity Conservation and Development Committees (BCDCs) to maintain CBR (Subedi et al., 2005), BCDCs are found to be the most accepted institution since; it was found to be more complete, legitimate, focused and sustainable. The result showed that there should be some institution with inclusive representation of the custodian of GR and ATK in community to national level for effective implementation of ABS regime.

EMPOWERING COMMUNITIES FOR MAKING DECISION ON CONSERVATION AND USE

Researchers have verified that CBM approach is effective in empowering farming communities in applying wide ranges of practices for conservation and utilization of agricultural biodiversity (Subedi et al., 2006). These practices supporting on-farm management allow for improvement of farmers' control over and access to crop genetic resources (Bragdon and Jarvis, 2002. CBM provides the communities with the knowledge and skills on analyzing the available biodiversity and enhances their capacity to build CBM Plan. CBM uses Four Cell Analysis and some other tools for analyzing biodiversity followed by Village Level Workshops to analyze and finalize the plan.

ADDING VALUE TO THE GENETIC RESOURCES AND ATK

Addition to the value of genetic resources is needed to enable the communities conserving the important genetic resources to take direct and visible benefits sustainably. CBM framework is based on the strategy of "conservation through use". Two types of value addition are generally practiced in the communities i.e. adding value through product diversification and marketing; and adding value through breeding. They are breeding and non-breeding approach.

Product diversification, value addition and marketing of local GR: Product diversification, value addition and linking to the market for a local GR were found to be extremely useful tools for conservation of local GR, and provide the incentive for the communities involved in conservation of the GR and ATK on farm (Sapkota et al., 2006). CBM approaches empower the communities to add value in the potential genetic resources and link them to the noble market. The benefits of the value addition and marketing of the genetic resources distributes to an individual or a group of people, according to who are involved in the process. People who have the knowledge on the practice of growing, using, protecting and marketing the particular GR will be the one who benefit from it. Thus these approaches ensure that the incurring benefits from use of GR and ATK go to the ultimate custodian.

Adding Value on GR by breeding: Participatory Plant Breeding (PPB), Participatory Varietal Selection and grass-root breeding have been successfully used for on-farm conservation of local rice varieties (Gyawali et al., 2006a; Gyawali et al., 2006b). Many researchers see PPB as an essential step to securing the world's food supply. In the process, PPB also contributes to ensure FRs in various ways (Halewood et al., 2007) and promote benefit sharing from the use of local GR.

Current Nepalese draft legislations accept farmers as breeder but, the mechanism of providing ownership on new varieties to breeder farmers is not developed. Although varieties developed by PPB (e.g. Pokhareli Jethobudo, Barkhe 3004, Sunaulo Suganda) have already been released through National Seed board (NSB), none of these varieties are under the ownership of farmers. Findings show that it is necessary to protect the varieties developed by farmers, but the contribution of other farmers providing the genetic pool should not be undermined. Even breeder farmers perceive that there should be trade off mechanism for not to restrict the farmers' rights on PPB seed when protecting the ownership right.

Financing the PPB programmes will be a mechanism of indirect (Anderson, 2006) sharing of the benefit from use of GR. Finding showed that PPB products were found to be well accessed by farmers and communities have benefited by them irrespective of group.

COMMUNITY BASED SEED PRODUCTION (CBSP)

The CBSP system provides benefits to the seed growers and share benefits with large number of the crop grower farmers. CBSP has also been a mechanism to provide incentives for the PPB farmers. The results of PPBs showed that at least 29 farmers in PPB group producing seed of Mansara, Biramphool and Jhinuwa lines in Begnash VDC and at least 13 farmers from Kachorwa village producing seed of Kachorwa lines have been found to be benefited. Seed production of the PPB varieties is not restricted to those, who have been involved in the breeding process. This show CBSP can be a mechanism of to provide incentive for the breeder farmers and also source of benefits to the other farmers who only involve them in seed production. CBSP is found to be the most successful mechanism for down-streaming the use and dissemination of PPB and/or Client Oriented Breeding (COB) products (Witcombe et al., 2009).

CBSP fills a big need for seed where farmers can get seed of the varieties they prefer. CBSP may also be a mechanism to generate benefits from seed production and marketing of promising local varieties. With present lawsuit, commercial production and marketing of non-registered landraces is illegal and processes of registration of landraces are much difficult to follow by farmers, but CBSPs are coordinating the production and exchange of the seed of local landraces among farmers in the form of Truthful Labeled (TL) seed. Whether CBSP could be an option to ensure Farmers' Rights to save exchange and sell seed for livelihood purpose; and whether it could reduce the dependency of farmers on corporate led seed supply are matter of future study.

EXCHANGING LOCAL GR AND KNOWLEDGE

CBM framework embeds management of Community Seed Bank (CSB) as an important structural component of agro-biodiversity management. CSB has been proved to be effective in exchange of the traditional knowledge and GR in communities (Shrestha et al., 2004) and also has the potential for facilitating exchange of GR nationally and internationally. If CSB could be linked with National Gene Bank (NGB) and International Gene Banks (IGBs), it would very effectively be a model to exchange the GR in ex-situ and in-situ. Combining CSB with CBR and Prior Informed Consent (PIC) mechanism, would effectively facilitate the regulated exchange of GR and ATK.

Data collected from 120 households in Kachorwa VDC of Bara, show farmers perceive CSB have positive effect on increasing access to local seeds; development of new varieties; identification, conservation and promotion of local landraces. CSB also found to contribute in strengthening local and traditional seed system and promoting self storage of seed without affecting traditional practices of exchange of seed within and outside the villages. Many of these functions are attributing to strengthening local seed system and ultimately to ensure FR.

Table1: Frequency of farmers by their perception on effect of CSB on some attributes of seed system

Aspects of seed system	Negative	No effect	Positive	Very positive	Do not know
Access to seed of local varieties			59 (50)	37 (31)	23 (19.3)
Access to seed of improved varieties		18 (14.8)	66 (54.5)	10 (8.2)	27 (22.3)
Support in new variety development			66 (55.9)	19 (16.1)	33 (27.9)
Conservation of local landraces			65 (54.6)	23 (19.3)	31 (26)
Identification of local landraces			72 (61)	10 (8.4)	36 (30.5)
Protect ownership of local genetic resources		2 (1.6)	64 (53.7)	5 (4.2)	48 (40.3)
Local seed system	1 (0.85)	11 (9.4)	54 (46.1)	2 (1.7)	49 (41.8)
Self storage of the seed in household	14 (11.6)	29 (24.1)	45 (37.5)	2 (1.6)	30 (25)
Exchange of seed from /to neighbors	9 (7.62)	48 (40.6)	26 (22)	5 (4.2)	30 (25.4)
Exchange of seed to other villages	11 (8.66)	57 (44.8)	23 (18.1)	1 (0.78)	35 (27.5)

Figures in parenthesis indicate the percentage of the row total

It was found that about 82% of the farmers perceive that CSB may enjoy the ownership of the local landraces maintained by it and 69% of them felt that CSB can enjoy the rights to provide PIC to the outsiders on behalf of the farming communities.

The national gene bank is under establishment in Nepal. The NGB has huge potential of reducing the cost of collection of the genetic resources from CSBs if the proper coordination between NGB and CSB established. The process of continuous development in the GR through in-situ conservation could be ensured through proper linkage of CSB with NGB. Moreover, through linkage of NGB and CSB, farmers may have easy access to the variety of options of GR to domesticate and repatriate (Majaju et al.,).

Moreover, CBM also have specific tools for locating, identifying and sharing the biological diversity and traditional knowledge i.e. biodiversity fair. CBM frame include biodiversity fair, where farmers collect and put all the biological diversity in their area, share the knowledge about particular biodiversity, exchange the seed and planning materials among them. Biodiversity fairs were found to be very much effective in exchanging the genetic resources and ATK, within community (Adhikari et al., 2004). Analysis of diversity fair on its effectiveness to disseminate different message showed that it was found to be effective in creating awareness and interest among diverse stakeholders on the importance and value of local genetic resources and making the spectator feel about the ownership.

PROVIDING ACCESS TO GENETIC RESOURCES

Providing access to genetic resource is very important part of implementing ABS regime. Although, the access to the genetic resources will be on the basis of Material Transfer Agreement (MTA) between party seeking access and a National Authority, the role of the communities in providing access is also fundamental. The role of communities in the process is given through the right of providing PIC. The provision of providing the PIC report by Village Development Committee as mentioned ABS bill – 2003 is against the principle since PIC is the role of the holder of the GR and ATK. PIC should be granted by individual/group holding GR and ATK but not by any part of the government like VDC. A community institution, which represents all the holders of GR, would be necessary to grant the PIC. CBM framework establishes the Biodiversity Conservation and Development Committees in VDC level for coordinating management of biodiversity in community level; and granting PIC and facilitating the process of distributing benefit could easily be the part of their role.

DISTRIBUTING THE BENEFITS

Any of the mechanisms described above could be the part of benefit sharing package in indirect benefit sharing. Because, financing "Value addition projects (both breeding and non-breeding), CSB and CBSP have shown that the ultimate benefits been distributed fairly and equitably. Moreover, CBM framework encompasses mechanism to distribute benefits aroused from use of common property resources including genetic resources within community. Community Biodiversity Management Fund (CBM fund) is found to be the mechanism to fairly and equitably distribute monitory benefits raised from the commercial use of GR and ATK (Paudel et al., 2010). CBM funds are established in revolving fund mechanism, to support conservation of local genetic resources and generate benefit by using them. Findings show that CBM fund is being operated as a mechanism to provide incentive for farmers especially to the minorities and woman for being involved in conservation (UNDP/SGP, 2009).

The mechanism of mobilizing CBM fund shows that each and every household in the VDC are eligible in taking loan from the fund. Findings indicate that the fund is distributed in all wards of the VDCs and has reached in hand of up to 7% of the total households in a single year. With the experience of success in equitably distributing benefits by CBM fund in community level, there is an ample possibility that the monitory benefits acquiring from the use of community GR could directly go to this fund and shared equitably and used in biodiversity management and community welfare.

Table 2: Summary of CBM fund users in study sites in 2009

S.N.	Site	Total fund (NRs) contribution			No. of users of fund			Coverage
		Donor	Community	Total	Male	Female	Total	
1.	Kachorwa, Bara	500000	30000	530000	10	80	90	All 9 wards
2.	Jogimara, Dhading	150000	15300	165300	29	21	50	All 9 wards
3.	Tamaphok, Shankhuwasabha	150000	15000	165000	25	23	48	29 farmer groups of all 9 wards

COMMUNICATE POLICY AND LEGAL MESSAGES TO COMMUNITY

Farmers and local communities perceive and interpret policies differently from decision-makers (Subedi et al., 2003). Farmers' management of the specific varieties on his/her farm is determined by farmers' understanding of many agro-ecological and socio-economic factors; including the government policies. CBM framework includes different tools and approaches to communicate policy messages to the community. Community level events like biodiversity fairs, folk song competition, rural street drama, village level workshops, joint monitoring visits and community level trainings are generally organized to disseminate the knowledge on biodiversity management and related policy message in communities. Specific tools like village level workshops and trainings were found to be most effective to communicate the legal message on biodiversity, but methods like biodiversity fair and folk song competition were also equally useful to aware the mass on their right and responsibilities regarding conservation and use of GR.

Table 3: Comparison of different communication methods based on judgment of 7 users taken through rating

Communication methods	Communicate policy message	Number of Audience	Interest of community	Participation of people	Effect	Cost
Folk song competitions	**	*****	*****	*****	**	***
Diversity Fair	***	*****	*****	*****	****	*****
Rural street drama	***	***	****	**	***	***
Village level workshops	****	**	***	***	***	***
Trainings	****	**	***	**	***	***

* Very low, *****very high

The effectiveness of the biodiversity fairs to communicate different concepts were analyzed by asking about 78 spectators randomly selected in the fairs about how many of the concepts they noticed and how many of them they understood. Result showed that on an average, respondent noticed about half of the concepts (8.6±0.5) and understood 6±0.6 messages out of 16 that has been asked. The study showed that biodiversity fair is very effective tool in disseminating knowledge related to concept and importance of local biodiversity, mobilize the mass in conservation of biodiversity and local resources and making people realize their right on GR and ATK.

CONCLUSION AND RECOMMENDATIONS

Community-based Biodiversity Management (CBM) is a participatory approach to empower farmers, farming communities, and local institutions in managing biodiversity for social, economic and environmental benefits to the community, as well as to the general public. It includes good practices, proven to be effective in in-situ conservation of biodiversity, it provide a base for a range of practices which may serve as the basis for IRABS to be affable and affordable to local communities. Regarding documentation and the sharing and conservation of genetic resources and ATK, CBM provide options of participatory tools and practices like the CBR, Biodiversity Fair and CSB. It also accommodates a range of practices, such as Participatory Plant Breeding, Participatory Varietal Selection, Value Addition and Market Promotion of local genetic resources and Community-Based Seed Production successful in pragmatic adoption of “Conservation through Utilization”; financing on these activities could easily be course to indirect sharing benefits, fairly and equitably. Moreover, CBM also provides a model institutional structure to ensure the right of the holders of GR and ATK on providing PIC during access to genetic resources and sharing the benefits accruing from the commercial use of those resources and knowledge. Gap in the legal base on registering such type of innovative institutional structure in Nepal, there is instant need of provision for registering the farmers’ organization in Nepal.

There are very few well accepted and proven innovative mechanisms for trickling down IRABS into the local communities. Further study may be necessary to generate more evidence on the appropriateness of some of the CBM tools on implementing IRABS, but relevance of most of the tools are already proved and realized by large groups of the stakeholders. The findings of the study on the CBM framework would be very much useful for tracking down the legislation of Nepal on regulating ABS regime.

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1. The manuscript must be an original work written in English and not published elsewhere.

2. The title should be short and specific, but it should reflect the contents in the manuscript.

3. The abstract, as far as possible not exceeding 150 words, should concisely state major objective, methodology, findings and conclusion. It should not include diagram, footnote, equation or any parenthetical reference.

4. Key-words in alphabetical order should not exceed ten standard words.

5. Main text of the technical manuscripts should include introduction, objective, theoretical framework, methodology, result and discussion and conclusion. The journal has preference on technical (research-based) articles over reviews. However, it also provides space for outstanding review-based manuscripts; main text of which, in general, should include introduction, objective, discussion and conclusion.

6. The manuscript should not exceed 4500 words in total. It should be in MS-word with pages set on A4 size, the top and left margins at 3cm and the right and bottom margins at 2.5cm. The text format should be on Trebuchet MS font of, unless otherwise specified, 11-point size.

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   d. In tables, borders should be minimized, and text and numbers should be in 10-point font size.

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For a book: Burkitt, M.C., 1977. The Old Stone Age. New Delhi : Rupa Publication Co.

For a journal article: Adhikari, G.P., 1994. Urbanization and its determinants in Nepal. Public Administration Journal, 15(1):31-37.

For a magazine article: Pandey, R.R. and P.M. Pradhanang, 1995. Potato wilt and its control measures (Nepali). **In:** Prabidhi Sangalo, vol. 9(3), pp. 99-102. Lumle Agriculture Research Center, Pokhara. Nepal.

For a year book/ report/ periodical: UNESCO, 1986. Statistical yearbook. Paris : UNESCO Press.

National Pay Commission, 1992. A report on the pay structure for civil servants. Kathmandu: Aradhana Press.

For a workshop proceedings: Gauchan, D., Sthapit, B. and A. Subedi, 2005. Community biodiversity register: a review of South-Asian experience. **In**: Subedi A., Sthapit B., Upadhaya M. and D. Gauchan (eds.), Learning from Community Biodiversity Register in Nepal, Proceedings of the National Workshop 27-28 October 2005, Khumaltar, Nepal, pp.3-13.

For a newspaper: Sunuwar, D.K., 2008. Ecosan toilets bring multiple benefit. The Kathmandu Post, Vol. XVI(167), Aug 3, 2008:p.3(col.3).

For edited works: Danziger, S. and P. Robert, 1982. The war on income poverty: achievements and failures. **In:** P.M. Sommers (ed.), Welfare Reform in America, Boston : Martinus Nijhoff, pp. 31-52.

For thesis/dissertation: Pokhrel, D. M., 2005. Citrus marketing system in the mountains of Nepal: a study based on market structure, conduct and performance analyses. PhD dissertation submitted to School of Environment, Resources and Development, Asian institute of Technology, Thailand.

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